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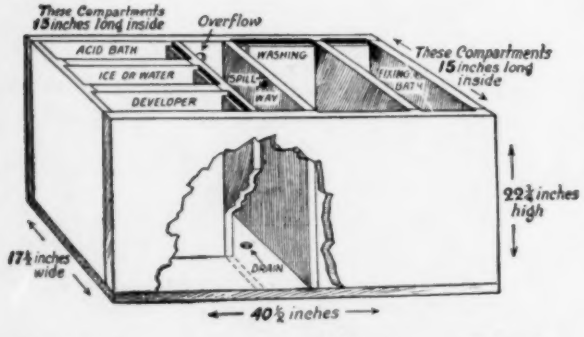

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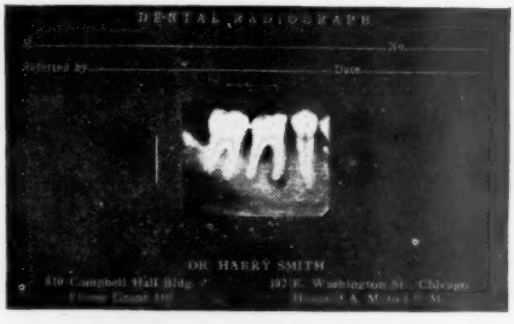

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OIL-IMMERSED X-RAY GENERATING OUTFITS*

By W. D. COOLIDGE

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SCHENECTADY, N. Y.

I. INTRODUCTION.

THE medical application of the *x*-rays has almost invariably been attended by the possibility of accidental electric shock to either the patient or the operator. In the early history of the art, contact with the high tension circuit involved only annoyance and discomfort; but with the advent of high-power installations, that which had been merely a possible source of annoyance became a real danger.

This danger could, at any time, have been eliminated by putting the entire high tension system, including the tube, into an earthed metallic enclosure. This method, however, when applied to earlier forms of *x*-ray apparatus, would in general have rendered them bulky and, mechanically, relatively inflexible.

With the advent of a self-rectifying *x*-ray tube, which is stable and can be made very small, it became interesting to mount the *x*-ray tube inside of the transformer tank and in the same oil with the transformer. The following consists of a description of a small experimental model of such an outfit, together with a discussion of some of the possible modifications and a summary of the inherent advantages and limitations of the method.

II. DESCRIPTION OF A SMALL EXPERIMENTAL MODEL.

1. *General Description.*—A complete oil-immersed outfit is shown in Fig. 1. The rectangular metal box, adjustably mounted on the tube stand, contains the *x*-ray transformer and, below this, the special *x*-ray tube. A low tension cable is seen leading from this, the generating outfit, to the control box at the right of the picture. A second cable, attached to the other end of the control box, leads to the supply mains.

A side view of the generating outfit in partial cross section is shown in Fig. 3. (In this case the cone has been removed and the outfit has been rotated through an angle of 180° from the position shown in Fig. 1, so that the *x*-ray tube is now above instead of below the transformer.) Fig. 4 shows a partial sectional end view. In Fig. 3, 1 and 2 are the high tension coils of the transformer. The tube is mounted directly over these. It is made of thick lead glass with a small lime-glass window which is set to face a thin re-entrant window in the bakelite cover, 3, of the tank. The *x*-rays which emerge from the tank have to pass through these two windows and a thin intervening layer of oil.

To permit of operation in all positions, two oil-expansion chambers, 4 and 5, in Fig.

*Read at Twentieth Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Saratoga Springs, N. Y., Sept. 3–6, 1919.

4, are provided at the bottom, and the balance of the tank is completely filled with oil. (One of the oil-expansion chambers, 5, is also seen in Fig. 3.)

The tank is of metal, and the cover, 3, is of bakelite. A thin layer of aluminum may be mounted on top of this and metallically connected to the tank. If then the tank is connected to earth, the whole high tension system is inside of an earthed metal enclosure from which nothing but *x*-rays can emerge. The high-tension danger is then seen to be completely eliminated.

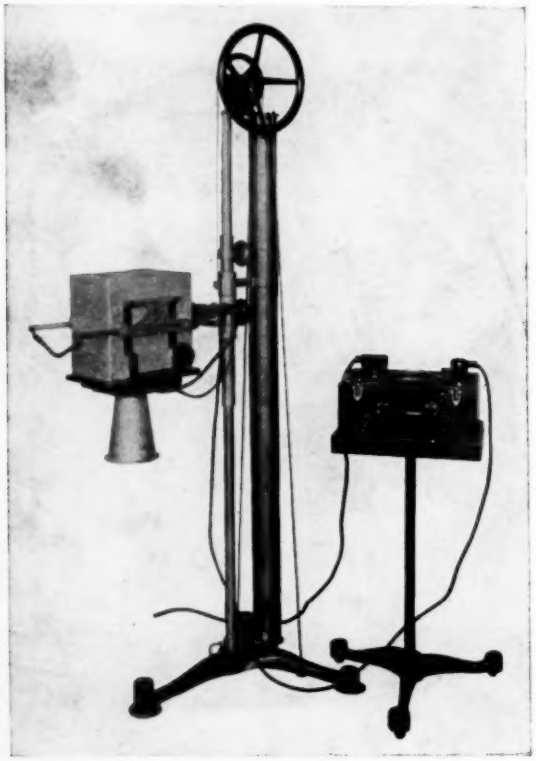

FIG. 1.

The generating outfit, as shown in Fig. 3, is suitable for 10 milliamperes at 60000 volts (useful), and weighs 54 pounds. Light weight is of course desirable to promote ease in handling. Furthermore, the weight of the generating outfit determines the weight and bulk of the supporting stand.

2. *The Transformer.*—The transformer is made as small as is consistent with the satisfactory operation of a tube rectifying its own current and carrying the above mentioned load.

3. *The Tube.*—As the bulk of the metal tank which is to contain the transformer and tube is partly dependent on the size of the latter, it becomes desirable that the tube shall be small. There is also another reason for this, for the smaller the bulb and the shorter the anode arm, the shorter will be the heat path from the focal spot to the outside cooling medium, and, hence, the more effective will be the cooling of the anode.

As has been pointed out elsewhere,[1] the size of bulb may be reduced by the use of thick glass. This brings with it the same improvement in operation in oil as it does in air.

For operation in oil, the side arms of the tube may be made very short. (For use in the air they have to be relatively long to prevent arc-over between terminals and to prevent leakage over the surface of the glass, especially in damp weather.)

Fig. 2 shows a full size cross-sectional drawing of the tube, which operates well in oil at 60000 volts (useful). Both 5 and 10 milliampere models have been built, and the same design with the same dimensions, but with larger focal spots, should be equally well suited to tubes of higher current-carrying capacity. Except for a small transparent window of lime glass, this tube is made throughout of glass containing 55 per cent by weight of the element lead.[2] This glass offers the same protection as sheet lead of one-fourth its thickness. The wall-thickness of the bulb is ¼ inch, hence the protection offered is equal to that of 1/16 inch of sheet lead.

As the outer end of the copper anode rod is in direct contact with the oil, no radiator is required.

[1] W. D. Coolidge, AMERICAN JOURNAL OF ROENTGENOLOGY for July, 1919, pp. 8-10.

[2] With the oil immersed type of outfit, *x*-ray protection could readily be obtained by lining the tank with sheet lead, but weight and bulk are saved by securing protection through the use of the high lead-content glass for the tube.

4. *Air Tanks to Permit of Operation in Any Position.*—The location of the tube in the same oil with the transformer results in a greatly increased heating of the oil, and, hence, in a greatly intensified oil-expansion problem. Of, say, 1000 watts of electrical energy delivered to the primary of the transformer, all but about 0.03 watts (the energy in the useful *x*-ray beam which comes out through the tube-window) will be finally delivered to the oil in the form of heat energy.

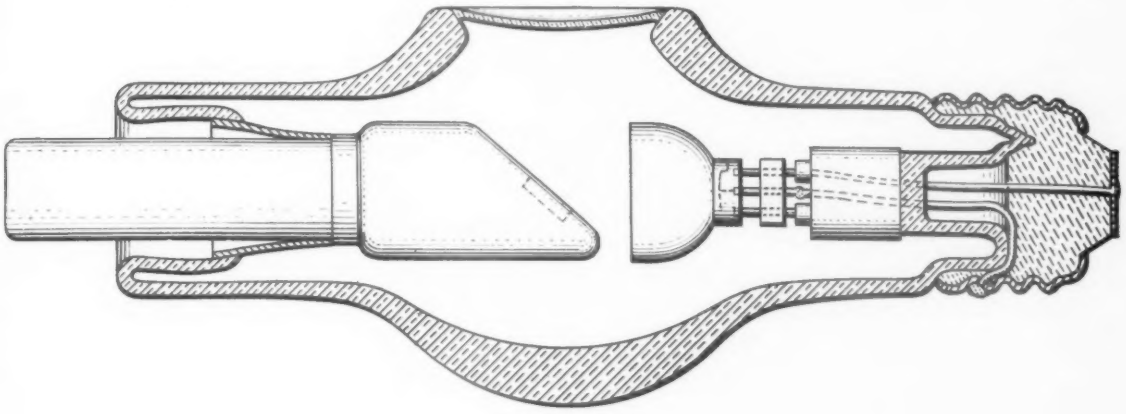

FIG. 2.

The tank and other metal parts involved, expand relatively little, but the oil expands strongly on heating. As a result, with the outfit in question, there is an oil expansion of 10 cubic centimeters for each degree C. of temperature rise.

A natural way of taking care of this would be to leave an air space in the top of the transformer case, and then, as the oil expands, it would compress the air in this space. But to save weight and bulk, the tank is made as small as is safely consistent with the required high tension insulation. Such a transformer could be operated when right side up, but in certain other positions it would be found that there was air where there should be oil, and that the transformer, if operated, would break down.

The field of usefulness of the device is greatly extended by making it possible to operate it in any and all positions. This result is attained by the use of the air chambers, 4 and 5, in Figs. 3 and 4. These air chambers are made of thin sheet metal and connect in each instance with the main tank by means of a metal capillary tube (6 and 7) leading to the center of the chamber. Such an amount of oil is originally put into each of these tanks that, even at the lowest temperature to which the device will ever be subjected, the inner end of the capillary will always be below the level of the oil in the chamber. The balance of the chamber is filled with air at atmospheric pressure. The main tank is filled full of oil so that the only air in the device is that in the special air chambers.

Figs. 5 and 6 show the position of the oil level with respect to the inner end of the

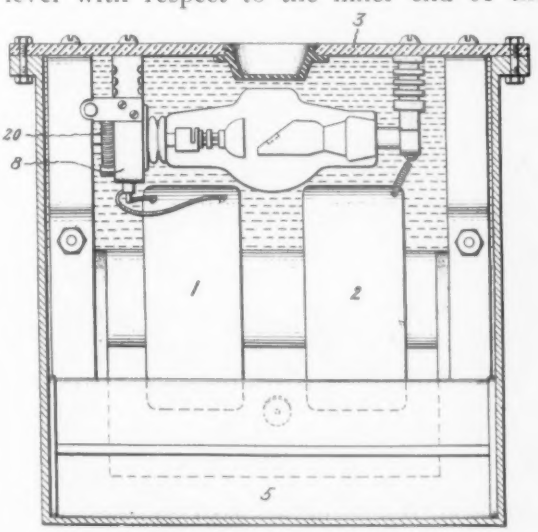

FIG. 3.

capillary tube, with two other positions of the air chamber 4. In no position of the chamber can the air escape into the main tank.

5. *Allowable Temperature Range of Operation.*—With the design in question, the total amount of oil involved is 11200 c.c. The total volume of air at atmospheric pressure in the tanks is 710 c.c. If the oil is allowed to expand until this volume of air is reduced to ¾ of this amount, the pressure on the inside of the tank will be 4/3 of what it was and will amount to 5 pounds per square inch above the atmosphere (neglecting the effect of temperature acting directly on the gas pressure). This is a reasonable pressure for the transformer tank in question and allows an oil expansion of 177 c.c. As the oil expansion is 10 c.c. per degree C., an expansion of 177 c.c. will correspond to a temperature rise in the oil of 17.7°C. above the 20° at which the case was filled.

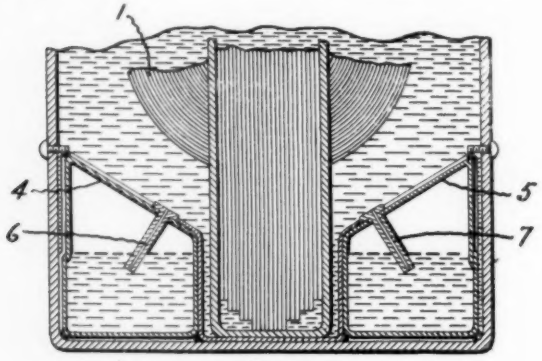

FIG. 4.

As has been said, the air tanks were originally filled more than half full of oil; enough so, in fact, to allow the oil temperature to drop to 0°C. before air can escape from the air tanks. The outfit as it stands then can be conservatively operated with an oil temperature ranging from say 10° to 38°C.

This allowable temperature range can, of course, be extended by the use of larger air tanks.

6. *Allowable Time of Continuous Full-Load Operation.*—Assuming 18°C. as the allowable temperature rise above that of the room, it is interesting to calculate how long the outfit can be continuously operated with 10 milliamperes at 60,000 volts.

The electrical efficiency of the transformer has not been measured, but for this rough calculation it may be assumed that 80 per cent of the energy put into the primary is delivered as high tension electrical energy to the tube. In this case there is an input into the transformer of $\frac{600}{.80} = 750$ joules per second $= \frac{750}{4.2} = 180$ calories per second.

The heat capacity of the system is 6000 calories per degree centigrade.

To raise the temperature 18°C., will call for operation for $\frac{6000}{180} \times 18 = 600$ seconds $= 10$ minutes. This time could be extended by the use of larger air tanks, which would permit of a greater allowable temperature range.

7. *Wiring Diagram of Generating Outfit.*—A schematic wiring diagram is shown in Fig. 7, in which 21 is the low tension coil of the transformer and 1 and 2 are the high tension coils. Coil 23 consists of but a few turns of relatively coarse wire. It is electrically connected to the high tension coil 1, and serves as a source of heating current for the filament of the *x*-ray tube. The filament

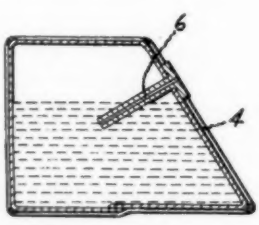

FIG. 5.

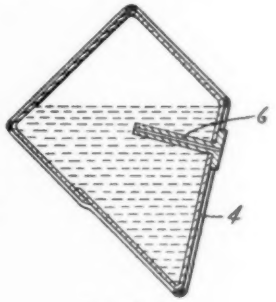

FIG. 6.

current is controlled by a little rheostat 8. Wires lead from the inner ends of the high tension coils out through the metal tank, indicated in the figure by the dotted rectangle, to 24, a milliamperemeter located in the control box. At the bottom of the figure,

a connection is shown running from the metal tank to ground.

8. *Mechanical Means for Adjusting Rheostat in Filament Circuit.*—Fig. 9 is a sectional end view of the upper portion of the generating outfit. (For the sake of clearness, it is drawn to a larger scale than the corresponding side and end views, Figs. 3 and 4.) It shows a mechanical means for adjusting the rheostat, 8, in the filament circuit, from outside the tank. (See also Fig. 8, which is a length section of the rheostat.) The little rheostat consists of a spiral of resistance wire, 20, which is mounted on a circular insulating support, which also carries the receptacle into which the cathode base of the tube screws. The rheostat contact arm, 10, and the two ratchet wheels, 11 and 19, are rigidly connected together and rotatably mounted on a horizontal shaft. The teeth of the two ratchet wheels point in opposite directions. The metal fingers 12 and 13 are made of flat spring material and are carried by the bakelite push-rods 9 and 18. Each of these fingers engages with one of the ratchet wheels. If one of the push-rods, 9, for example, is alternately pushed and released, it produces a clock-wise rotation of the rheostat contact-arm 10. A similar use of the other push-rod results in counter-clock-wise rotation of 10. The push-rods are operated by means of the push-buttons 14 and 15, each of which is attached to a flexible diaphragm in the side wall of the metal container. For greater flexibility, pieces of Sylphon tubing, 16 and 17, are used in place of flat diaphragms. The inner surface of each flexible diaphragm rests against the end of one of the push-rods.

One push-button then serves to increase the filament current and, hence, the milliamperage flowing through the tube, while the other serves to lower it.

9. *The Control Box.*—This is, with a few changes, like one which has already been described in a paper on apparatus for portable work.[3] It is shown in Fig. 10 and contains an auto-transformer with a multiplicity of taps and corresponding special switch. By means of this combination it is possible to vary the voltage supplied to the *x*-ray transformer by steps of 2 volts through a range of 32 volts.

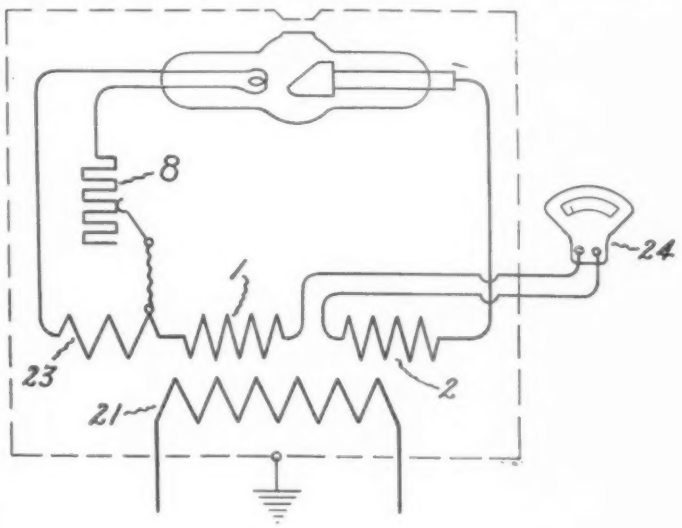

FIG. 7.

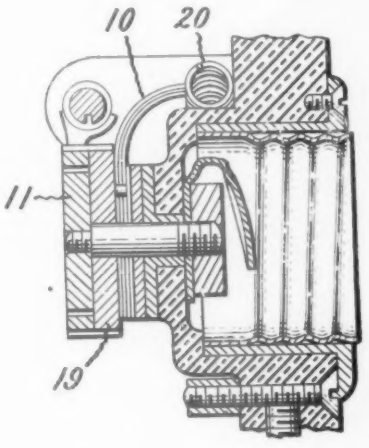

FIG. 8.

The voltage delivered by the auto-transformer to the *x*-ray transformer is indicated by a voltmeter, and the corresponding high tension voltage is known from a sphere-gap calibration made before the transformer was put into the tank.

Current passing through the tube is shown by a milliammeter, which is connected in to

[3] l.c. pp. 13-16.

the middle point of the high tension secondary. There is also a circuit-breaker, time-switch, pilot lamp and push-button *x*-ray switch.

10. *Method of Operation.*—If the voltage is to be kept constant, at 60,000, for example, the operation is very simple. With this particular outfit, a sphere-gap calibration has shown that for 60,000 volts and 5 milliamperes, a primary voltage of 105 is required. The resistance in the filament circuit is then adjusted so that the tube carries

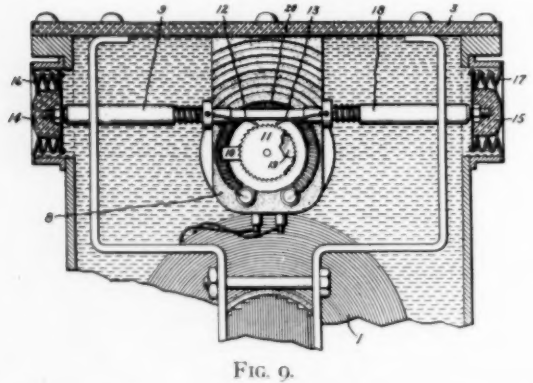

FIG. 9.

5 milliamperes when the primary voltage is 105. It should then be unnecessary again to touch this adjustment of the rheostat in the filament circuit. The milliamperage can be subsequently controlled by the auto-transformer switch, and as the following data will show, this can be done without appreciably affecting the high tension voltage. This is due to the fact that the filament current is determined by the primary voltage and that the electron emission goes up so very rapidly with the filament current.

Primary Volts	*Milliamperes*
101	4.2
104	6.0
106	8.7

In the above table, the primary voltage has been increased by 5 per cent, and this has caused an increase of 107 per cent in milliamperage. A sphere-gap calibration of the transformer shows that the corresponding secondary voltage increase was only 3 per cent. In other words, the above method of regulation made it possible to increase the milliamperage 107 per cent while the secondary voltage increased only 3 per cent.

This method of operation has a great deal to recommend it, especially in radiographic work. If the line voltage is constant, there is nothing to do in making the exposure but to set the time switch and press the button. When the line voltage is very variable, one has merely to see that the voltmeter reading is right before closing the switch, and then, if necessary, operate the auto-transformer switch during the exposure to hold the milliamperage constant.

III. AIR COOLING OF AN OUTFIT FOR CONTINUOUS OPERATION.

For continuous operation or for any sufficiently severe service, the cooling of the oil could be facilitated by the use of a fan or blower and cooling vanes on the outside of the tank. In this case it would also help to make the tank of some good heat-conducting metal, such as copper.

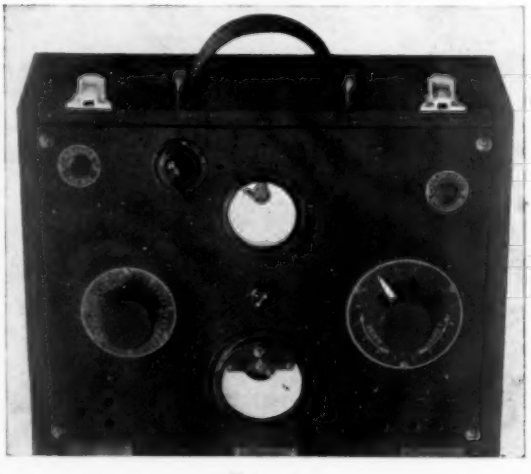

FIG. 10.

IV. WATER COOLING FOR THERAPEUTIC OR OTHER HEAVY DUTY WORK.

Cooling coils of copper tubing could be placed inside of the oil and at a safe distance from the high tension system, or such cooling coils could be soldered to the outside of

the tank. In either case, tap water could then be safely passed through the cooling coils. It will be seen that this is entirely different from the ordinary water-cooling of an *x*-ray tube, for it does not in any possible way endanger the patient. Nor does it necessitate insulating the cooling water. Furthermore, owing to the absence of corona, rubber tubing can be satisfactorily employed as a flexible means of getting water to and from the copper cooling coils. (Rubber disintegrates very rapidly in the neighborhood of high tension discharges.)

V. DIRECT WATER-COOLING OF THE ANODE.

This is also possible with the oil-immersed system, for the tubular anode rod can be soldered in to a metal plate, and this plate can, in turn, be fastened with a gasket into a hole in the wall of the tank. In this case it becomes desirable to connect the inner end of the high-tension winding directly to the metal tank and thence to earth.[4]

Fig. 11 shows a sectional view of a 40 milliampere, 60,000 volt model of this type which has been built. The schematic diagram of connections is shown in Fig. 12. In the light of the other diagrams, these figures are almost self-explanatory.

The cathode end of the *x*-ray tube is attached to a socket containing a little rheostat, which is flexibly mounted on the single high-tension coil of the transformer. The inner end of this high tension coil is connected through a milliammeter to the metal tank and thence to earth. The anode end of the tube is also electrically connected to the metal tank. The anode is cooled by tap water entering at *a* and leaving at *b*.

As the transformer is so small, and as this model was intended for continuous full-load operation, a water-cooling coil, *c*, is shown soldered to the outside of the metal container.

A window of bakelite or aluminum or some other material transparent to *x*-rays is mounted in the wall of the metal tank opposite the transparent window in the *x*-ray tube.

[4] For very high voltage work in air such a system is objectionable, for it results in increased corona trouble. This objection does not hold, however, in the oil-immersed outfit.

VI. FILAMENT HEATING FROM AN EXTERNAL SOURCE.

For certain applications, the cathode end of the tube may advantageously be connected to the metal tank and to earth. Such an arrangement is shown diagrammatically in Fig. 13. The transformer is here seen to have only one high tension terminal. The

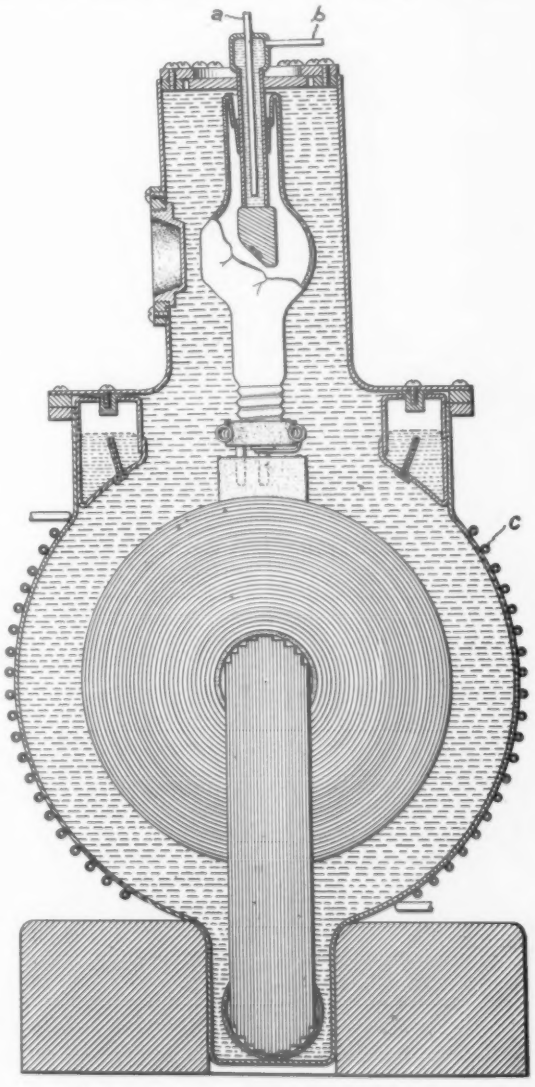

FIG. 11.

above system makes it possible to have the filament lighted before closing the *x*-ray switch (thus doing away with the time-lag which is otherwise present), and brings the control of filament temperature outside of the oil and, if desired, makes it entirely independent of the high tension voltage. This is, of course, conducive to extreme flexibility of operation.

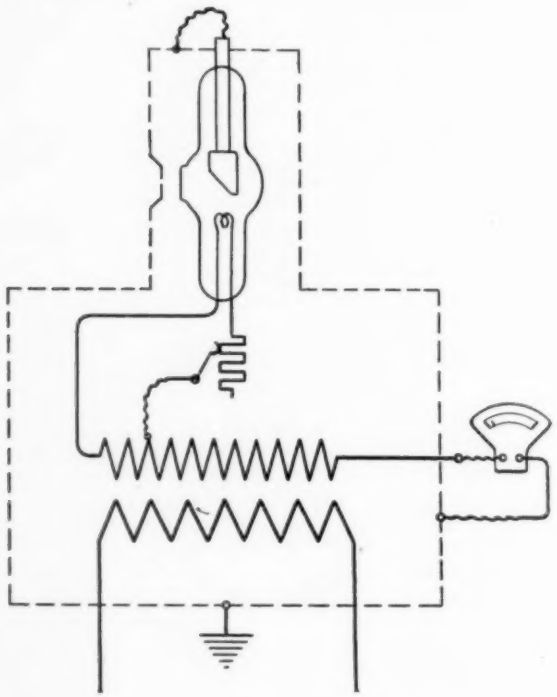

FIG. 12.

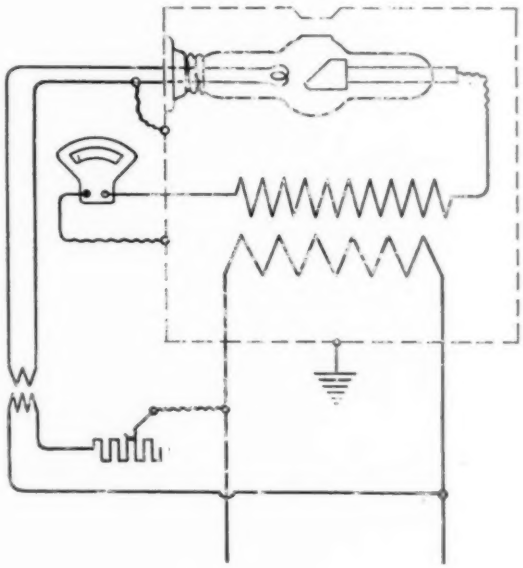

FIG. 13.

VII. POSSIBLE APPLICATIONS OF THE OIL-IMMERSED TYPE OF OUTFIT.

For radiographic work it seems thoroughly feasible to use such an outfit as that shown in Fig. 1. Higher power outfits of this same type should be equally satisfactory. One for 50 milliamperes and 60000 volts has been built. It is simply a larger edition of the one shown in Fig. 1 and weighs 75 pounds. In the field of radiography it is, perhaps, more especially in connection with high power work that the elimination of the high-tension risk will be most appreciated.

The application of such an outfit to general fluoroscopy is perhaps sufficiently obvious. It will be seen that when used under the table it greatly extends the allowable tube travel.

For fluoroscopic control in the reduction of fractures or any other surgical work, the oil-immersed type of outfit seems especially indicated, for it eliminates the electrical danger to the surgeon and his assistants, as well as doing away with the fire hazard attendant upon the use of high tension electricity in the presence of ether vapor. It can furthermore be used under the surgeon's operating table without the need of any precautions to keep blood and water off of it.

In therapy the oil-immersed type of outfit seems to offer special advantages. Aside from the general advantages, which will be summed up in the next section, it should help in work under the arm and in the treatment of body cavities. For the *x*-ray tube could be placed in a small cylindrical side arm leading off from the main transformer tank, as in Fig. 11 for example. This metal side-arm is connected to earth and could be

water-cooled. It could then safely be brought into contact with the patient. In this way, it would be possible to bring the focal spot of the tube to within a very short distance of the skin.

In experimental therapy, the system should make it possible to use, in a room of ordinary size, the highest voltage for which an *x*-ray tube can be developed.

VIII. ADVANTAGES OF THE OIL-IMMERSED SYSTEM.

The main advantages derivable from such a system are the following:

(a) Eliminates all danger of electric shock to patient or operator.

(b) Eliminates all corona discharges with attendant noise and odor.

(c) Eliminates fire-risk in presence of ether vapor.

(d) Makes it easy to get any desired amount of *x*-ray protection, for, if necessary, the tank itself can be lined with metallic lead.

(e) Makes practicable, even in small rooms, the use of as high a voltage as that for which an *x*-ray tube can be developed.

(f) Disposes of all light emitted by tube, which is a convenience in fluoroscopy.

(g) Makes it possible to bring the focal spot much nearer to the patient than is ordinarily practicable. This might be useful in certain therapeutic applications.

(h) Makes tube mechanically stronger by permitting use of shorter arms and a shorter anode rod.

(i) Gives greater heat conduction from focal spot to outer end of anode rod, by shortening the distance the heat has to travel.

(j) Assists in removal of heat from outer end of anode rod, as oil is a more effective cooling medium than air.

(k) Permits of safe and convenient use of tap water for cooling of oil or anode.

(l) Reduces danger of tube breakage by putting tube in a good damping medium (oil) and inside of a metal container. It furthermore eliminates all handling of the tube.

(m) Eliminates effect of humidity on performance of apparatus, a matter of considerable importance in moist climates. It also prevents the deposition on the tube of a conducting layer of salt spray at the seashore.

IX. A LIMITATION OF THE METHOD.

With such an outfit it is still necessary, in diagnostic work, that the focal spot of the tube shall be held stationary in space. As the weight of the tube and transformer is obviously much greater than that of the tube alone, the method necessitates a much more rigid, and hence larger and heavier, tube stand than would be required to support the tube alone.

In closing, the author wishes to acknowledge the assistance of Mr. L. E. Dempster and Mr. W. K. Kearsley, both of whom have actively contributed to the development work described in this paper.

DISCUSSION

DR. BYRON C. DARLING.—I would like to ask Dr. Coolidge about the volatilization of tungsten in his tube. The smaller you get your tube, the smaller the total area of your circumference, and I am not enough of a mathematician to figure out the proportional area between a 6 inch bulb and a 7 inch bulb and a 1½ inch bulb, but it runs somewhere between 1 and 5. That would make your smaller tube last a much shorter time, which would make our bill five times what it is now for the same exposure time. It seems to me that the work that is being done to refine the apparatus is work well taken and time well spent. It occurs to me that a combination of the transformer and rotary switch and oil as one unit, and a tube in oil as another unit with Dr. Johnston's safety device, and some overhead high tension system that is safe, may be the ultimate solution for a man who is doing nothing but *x*-ray work in his office. The portable outfit, of course, is another matter. I have wondered why Dr. Coolidge did not put a radiator on his 7 inch bulb, all tungsten target tube, also the regular size copper and tungsten anode. It would seem to me that if it is an advantage to

get rid of heat it might be used in every size. The small button on the tungsten and copper target self-rectifying tube favors the heating of the copper surrounding, and if over-heated, the whole button falls out. The button is too small now.

Another question I would like to ask is how large a milliamperage capacity can be built with the suppressed wave type of apparatus mentioned.

Dr. W. D. Coolidge.—The size of an *x*-ray tube should, I think, be kept as small as is consistent with satisfactory operation, and for the following reasons:

(1) A small tube lends itself to more complete *x*-ray protection.

(2) For a given amount of protection, the small tube with its protecting envelope will weigh less and can therefore be used with smaller, lighter, and more convenient accessories.

(3) It is less liable to breakage in handling.

With conservative operation, there is no appreciable blackening of the bulb of even the smallest *x*-ray tubes.

It is quite feasible to have the *x*-ray tube in a separate tank of oil instead of putting it into the same tank with the transformer. The latter system has several advantages, however, which are not possessed by the former. For example, it puts the entire high tension circuit inside of a grounded metal inclosure.

As to the question of how large a capacity you can have in a system where the tube rectifies its own current: I am very sure that there is no limit. We have operated self-rectifying water-cooled tubes continuously for hours at a time, with as much as 5 and even 10 kilowatts of energy, and there appears to be nothing but the size of the focal spot and the size of the anode to set a limit to the allowable energy input.

Dr. Byron. C. Darling.—Transformer 100 kilowatts?

Dr. W. D. Coolidge.—Yes indeed. There is no trouble at all. It simply means a suitable design and the use of plenty of iron and copper.

RADIUM TREATMENT OF ENLARGED THYMUS GLANDS IN INFANTS

By ARTHUR C. HEUBLEIN, M.D.
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UNTIL a short time ago inexplicable deaths in infants were in many instances erroneously attributed to a variety of causes, such as status lymphaticus (exclusive of status thymicus), foreign body in the throat, suffocation by the mother during sleep, or having a cat suck its breath.

In our present knowledge the above named causes of sudden death are now known to be due, in the majority of cases, to a pathological overgrowth of the thymus gland. According to Sajous,[1] in most instances of thymic death, the victim is a child found dead in bed, doubtless as a result of asphyxia due to tracheal stenosis, laryngeal spasm, or cardiac paralysis with an enlarged thymus found at autopsy, as sole evidence. Such cases may be the source of unwarranted accusations of criminal suffocation and an autopsy should always be performed if possible.

This gland normally occupies the anterior and upper part of the mediastinum, is encased in a rigid structure, the thoracic wall, and when enlarged presses on the trachea, the recurrent laryngeal and vagus nerves, the great vessels of the upper thorax and lower cervical region, and the right auricle.

Directly or indirectly, this overgrowth is the cause of sudden death in a great many infants. Unfortunately enlargement of the thymus gland has been, and continues to be to-day frequently overlooked. Although the patient may have no gross symptoms of thymic enlargement it may exist, and if unrecognized is a menace to life. Many infants die yearly as a result of heart shock during anesthesia. Before submitting an infant to an operative procedure demanding a general anesthetic, the previous history, and a thorough chest examination should be obtained, and in all suspicious cases, roentgenographs made.

Prior to the period when roentgen treatment of the disease became a recognized entity, benzoin and the croup kettle were freely used, the mother becoming expert in the technique of artificial respiration, and the attending physician calling at frequent intervals to see if the infant were still alive. Thanks to the ever increasing alertness of the pediatrician, and to the development of the *x*-ray as a diagnostic agent, there should be no excuse for this condition escaping recognition. Unfortunately it still does except in a few medical centers where this disease is looked for as a matter of routine. Its prevalence is well illustrated by Friedlander,[2] who states that in Dr. Benjamin's Out-Patient Clinic in Cincinnati, of all the new patients admitted during the year, namely 225, 8.4 per cent were indisputable thymus cases.

There are many theories as to the etiology of thymic enlargement, but as yet no definite cause can be assigned. Pathologists tell us that it is a simple hyperplasia of all the elements of the gland.

In November, 1919, Edward A. Park and Roy D. McClure[3] of Baltimore reported a series of experiments on dogs. The conclusions of their exhaustive investigation are as follows:

1. The thymus gland is not essential to life in the dog.

2. Extirpation of the thymus produces no detectable alteration in the hair, teeth, contour of the body, muscular development, strength, activity or intelligence of the experimental animal.

3. Extirpation of the thymus probably does not influence growth or development. The possibility that it may cause retardation in development and delayed closure of the epiphyses, however, cannot be excluded absolutely.

4. Extirpation of the thymus probably produces no alterations in the organs of internal secretion. It is possible that it produces well-marked changes in the organs of internal secretion in the period immediately following thymectomy which was not covered in their experiments.

FIG. 1. ILLUSTRATING BULGING OF ANTERIOR AND UPPER CHEST AND ECZEMA WHICH FREQUENTLY ACCOMPANIES THIS DISEASE.

Briefly, the symptoms of enlarged thymus may be divided into two groups, general and local. The former are muscular hypotonus, eczema, lack of resistance to acute infectious diseases, and convulsions. The latter consist of those symptoms arising from interference with respiration and deglutition due to the mechanical effect of the enlarged gland. They vary from a slight cough to profound dyspnea with or without associated cyanosis. The respirations are usually audible, and when dyspnea is severe there may be a distinct inspiratory "crow." These symptoms may be precipitated or aggravated by exertion, such as crying, feeding, fright, or by extension of the neck.

The diagnosis is made by the history, the physical examination, and the final and most accurate evidence, the roentgenogram. Inspection often shows a flabby child with retraction of the abdomen and intercostal muscles, with a bulging of the upper and anterior chest. Light percussion reveals an area of dullness to either side and continuous with the dullness over the sternum. It is usually more pronounced on the left side.

The roentgenograms show a shadow overlying and continuous with the shadow of the heart and great vessels. Its margins are usually convex, more prominent on the left than the right side, and extending upward beneath the clavicles, blending with the tissues of the neck.

To date I have treated 41 cases, 34 of which Dr. Brayton and I reported in the December number of the *Boston Medical and Surgical Journal*.[4] In this series a constant technique was observed in producing the roentgenographs. The patient was placed flat on the back, and a series of plates were made at a constant target plate distance until a plate was obtained which showed no distortion. Speed is an important factor, and of late I have found the double screen technique the most satisfactory.

A little over two years ago I was called in consultation by Dr. Howard W. Brayton, assistant pediatrician to the Hartford Hospital, to see an infant practically moribund from the effects of an enlarged thymus gland. The patient was markedly cyanosed and gasping for breath. An *x*-ray examina-

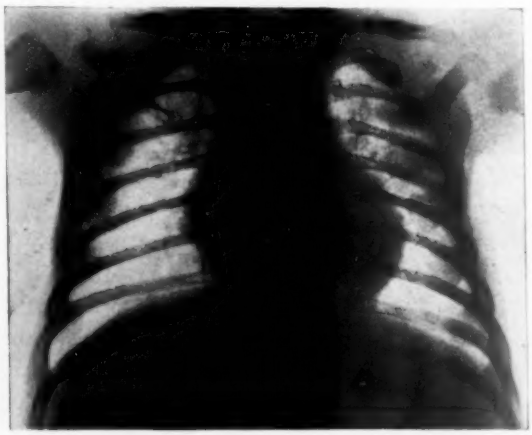

FIG. 2. NORMAL THYMUS SHADOW.

tion showed a thymus filling nearly half the chest. Although roentgen therapy was recommended, as up to this time it had proved to be the only effective method of treatment,

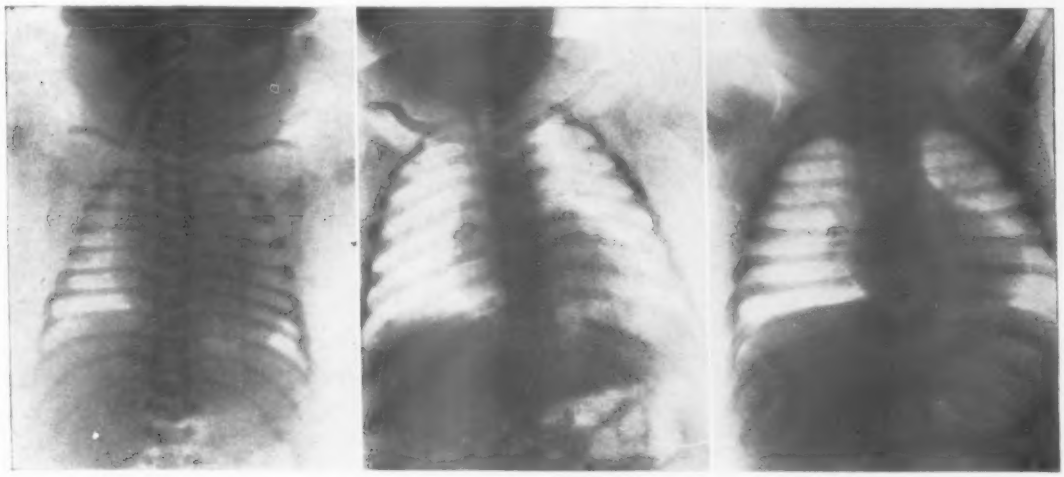

FIG. 3. CASE I. BEFORE TREATMENT. TWO WEEKS AFTER TEN WEEKS AFTER

yet partly from an experimental standpoint, and also in view of the fact that with radium I had observed a more rapid diminution in the size of other pathological overgrowths, I departed from the accepted method of treatment, and used radium.

The result was so eminently satisfactory in this case that I have treated all other cases in a similar manner. The technique which was followed was cross-firing with 100 milligrams of radium element, filtered through 0.3 mm. silver, at a half-inch skin tube distance through four portals of entry, the tube being placed over the anterior aspect of the chest directly over the thymus gland. The tube is left two hours in each position, which makes a total dosage of 800 milligram hours. As time is such an import-

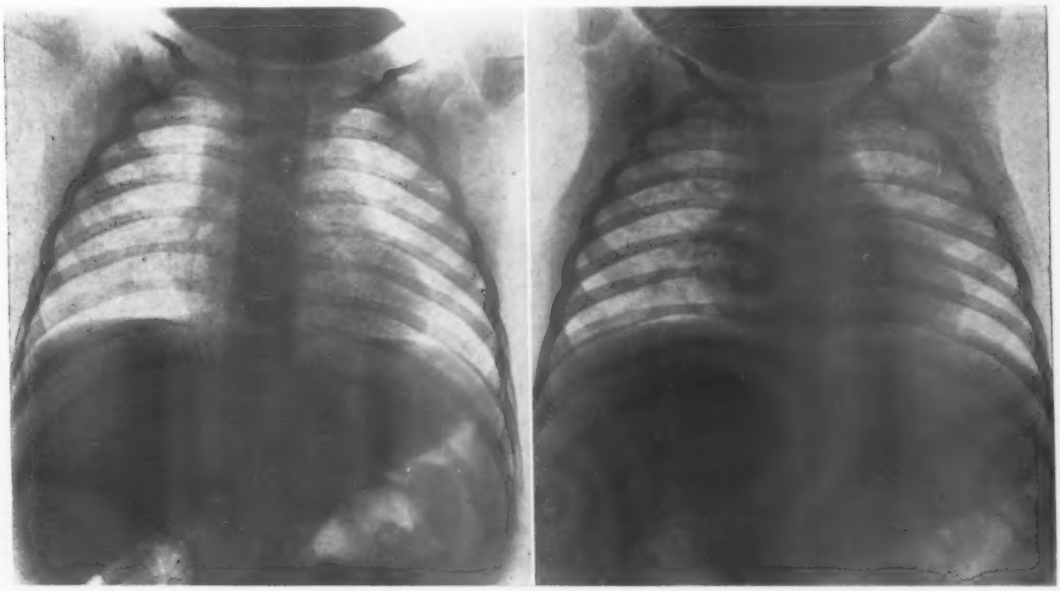

FIG. 4. CASE 2. BEFORE TREATMENT. ONE WEEK LATER.

ant factor in these serious cases I have now substituted 200 milligrams with half the time of exposure.

In my series of 41 cases the dosage administrated seemed to be sufficient to cure large as well as small thymic overgrowths in one application, and as now it is conclusively proven that the thymus has no function after birth, we need not fear over-treatment. None of my cases have shown any tendency to regeneration of the gland. Possibly these results could have been obtained by a single intensive *x*-ray treatment, but in reviewing the literature I find no such results reported.

In conclusion, I want to emphasize the following: Thymic enlargement is a common disease in infants. Radium as well as the roentgen ray is specific in its effect, but radium has the following advantages: It is portable; it gives the desired result in one treatment; it is simple, thus eliminating the dangerous element of fright, as infants resist the fixation necessary in roentgen ray treatment, and this very fixation may be the exciting cause of thymic crisis and death; radium is a safe procedure, as the skin tube distance never varies in the most refractory child.

Case 1. A male infant, 12 pounds in weight, was seen one hour after birth. The labor had been easy but with the first cry the obstetrician had noticed that the child's breathing was decidedly abnormal. The patient presented the most unusual appearance; the skin, lips and nails were intensely cyanotic and the inspiratory stridor was distinctly audible in the adjoining room, while the epigastric retraction was equal to that accompanying the severest forms of laryngeal diphtheria. Percussion and *x*-ray both indicated the presence of a thymus filling nearly one-half of the chest cavity, while inspection, palpation, and *x*-ray all revealed the presence of an enormous thyroid occupying the entire front of the neck as far back as the lobes of the ears. Radium was applied and within twenty-four hours the baby showed improvement and within forty-eight hours there was decided improvement, which continued until, at the end of a week he was nearly normal in appearance. It was interesting to note that the thyroid disappeared coincidently with the shrinkage of the thymus. The child was still perfectly well fifteen months after discharge.

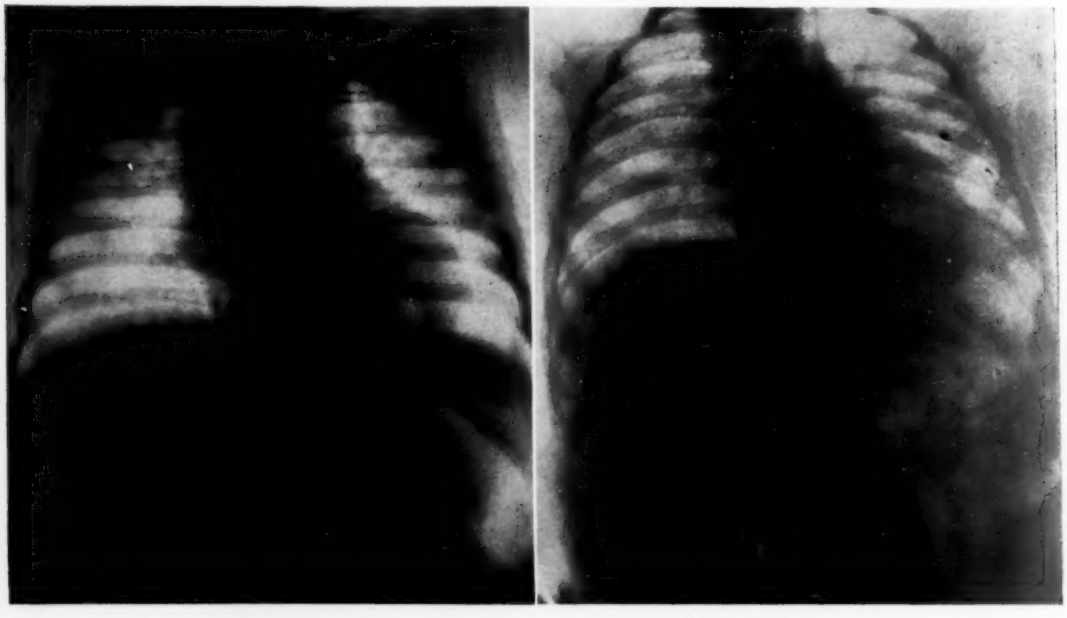

Fig. 5. Case 3. Before Treatment. One Week After.

Case 2. Male, fourteen months of age.

with a history of eczema, weakness and convulsions from birth. On close questioning these convulsive seizures were found to consist of the following sequence of events: sudden asphyxia, cyanosis, retraction of the neck, general clonic contractions, syncopy followed by exhaustion. Examination showed a flabby, eczematous child with bulging of the upper chest and well defined thymic dullness. *X*-ray corroborated these findings. Radium was applied. The child had no more convulsions and one week later the roentgenogram showed a normal thymic area.

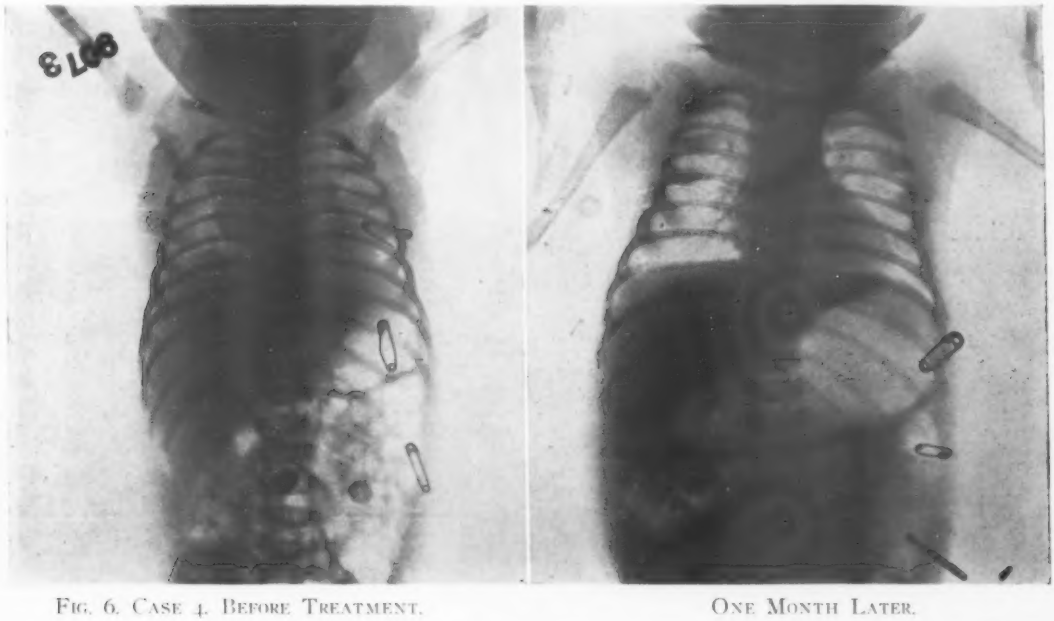

FIG. 6. CASE 4. BEFORE TREATMENT. ONE MONTH LATER.

CASE 3. A female of eleven months who had always breathed "as though she had a cold." Frequent attacks of choking and cyanosis, particularly at time of feeding. *X*-ray confirmed the percussion findings of enlarged thymus. One week after treatment the child was perfectly well.

CASE 4. Female infant, weighing at birth 10 pounds. Mother primipara with contracted pelvis, requiring extremely difficult high forceps operation. Child's head very much lacerated and left clavicle fractured. Because of these injuries the obstetrician attributed the peculiar breathing of the infant to cerebral pressure. The baby was cyanotic and cried with a peculiar crowing inspiration. Stridor and retraction were present, particularly during nursing and when head was extended. Three days after birth the infant was seen by Dr. Brayton, who found increased thymic dullness and referred the case to me. Five days after treatment the child was free from symptoms and has remained so to date.

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2. *Am. J. Dis. Child.*, July, 1917.

3. *Am. J. Dis. Child.*, November, 1919.

4. *Boston M. & S. J.*, Dec. 25, 1919.

TESTS OF X-RAY INTENSIFYING SCREENS

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IN SEEKING to determine the properties of various *x*-ray intensifying screens, some interesting facts were brought out. Some of the characteristics of intensifying screens were already known from practical experience, and the tests served merely to demonstrate them more clearly. Other peculiarities were found which had not been previously suspected.

Obviously to get the best results in intensifying screen work, it is necessary to know the characteristics of intensifying screens in general, and especially the qualities of the particular screen being used. One should know under what conditions a screen may be used with advantage, and under what conditions a screen should not be used. It is also desirable to be able to compare readily the qualities and merits of various screens.

The most important intensifying screen characteristics, from a practical standpoint, are speed (intensifying factor), definition, and graininess. These are not difficult to test practically. In the hope that our experience may be of use to other workers in radiography, we shall attempt to describe the methods we have used in testing screens, and the character of the results obtained.

The intensifying factors of the screens were determined by making radiographs of several subjects in the usual way, the intensifying factor being taken as the ratio of the exposure without screen to the exposure with screen to produce the same average density of negative. A standard exposure for each subject was given the film, loaded in the ordinary card board film holder. Several different exposures were made with the same subject upon the film with intensifying screens in an aluminum cassette. All the films were given the same standard development in Elon-hydroquinone developer. The resulting negatives were carefully compared by visual inspection to see which one made with screen had an average density equal to the one made without screen.

The ratio of the exposures of these two negatives gave the intensifying factor. In case a screened negative which matched the unscreened negative was not obtained in the first trial, the experiment was repeated until a match was obtained. Radiographs were made on four kinds of subjects, a hand, a spine, a wax knee, and a dry skull. The "wax knee" is a joint from a human skeleton, encased in wax which has been molded to the form of a human knee. This wax knee is a very satisfactory test object for radiographic purposes.

For all tests the Coolidge radiator-type tube was running at a 5-inch spark gap, 10 milliamperes, with a target film distance of 20 inches. The photographic material used was "Dupli-Tized" *x*-ray film. The exposures were timed by means of a sensitometer timing mechanism, with which exposures as short as 1/6 of a second could be obtained with quite satisfactory accuracy. The results obtained with several varieties of intensifying screens are given in Table 1, the different types of screen being indicated by letters.

TABLE 1

	Intensifying Factor for			
Screen	*Dry Skull*	*Wax Knee*	*Hand*	*Spine*
(A) Double	4.0	3.25	4.0	3
(A) Single	2.75	2.25	2.5	2
(B) Double	4.0	3.25	—	—
(B) Single	5.0	4.5	5	4
(A) Thin Front with (B) Thick Back	4.7	4.5	—	—

Exposure without Screens			
Dry Skull	*Wax Knee*	*Hand*	*Spine*
1⅜ sec.	1½ sec.	1¼ sec.	10 sec.

To obtain the exposure with any screen or combination of screens, divide these exposures by the intensifying factor.

Fairly strong negatives were obtained in these tests. Some workers prefer negatives of lighter density. Since intensifying screens in some cases increase the contrast of the negatives, the intensifying factors will then be smaller for lighter density of negative.

The factors for the hand and spine were not obtained for all the screens. The factors obtained with the wax knee appear typical of those obtained for the deeper parts of the human body. The results of the skull and wax knee are considered more precise than the others, since we were able to obtain more checks upon them.

With some screens, the double combination is faster than the single screen, as is shown by screen *A*; other screens are faster as single screens, as in the case of screen *B*. In each of the *A* and *B* double combinations, the front screen is thinner than the back screen. The *A* front screen is shown in Table 1 to be more effective than the *B* front screen when used in combination with the *B* back screen; but when the back screen is omitted, using each screen as a single front screen, the *B* front screen was found to be the faster of the two. This shows that the *B* front screen had the greater absorption and allowed less radiation through to excite fluorescence in the back screen. A front screen of such a combination should have low absorption for *x*-rays as well as a high intensity of fluorescence.

Since the *A* front screen increases the speed of the *A* back screen by about 50 per cent or more, it might be expected to increase the speed of the *B* single screen by a similar amount. However, such is not the case; the speed of the *A* front with the *B* back screen is but little different from that of the single *B* screen. This shows that the *A* and *B* back screens are differently affected by the change in the quality and intensity of the incident radiation produced by interposing the *A* front screen.

The thin front screen of a double combination usually makes nearly as fast a back screen as the regular thick back screen, and hence may be used as a back screen with no great loss in effectiveness.

All the screens gave greater contrast when used as a double than when used as a single screen. This explains the "snappy" and "brilliant" appearance of double screen radiographs. The low densities have been given less intensification than the higher densities, and are actually clearer than the same areas would be in the radiograph made without screens. The general fog due to scattered radiation is likewise less intensified in the lighter densities, and therefore shows up less than in a radiograph made without screens.

The intensifying factor depends to some extent upon the degree of development of the film; the image made by the intensifying screen lies near the surface of the emulsion, while the *x*-ray image penetrates the whole depth of the emulsion, and these two images develop at different rates. The standard development used in these experiments was 5 minutes in Elon-hydroquinone developer, in a tank, at 65 degrees Fahrenheit.

Table 1 shows that for each screen the intensifying factor varies with the part radiographed; this effect was carefully checked. The values for the spine and the wax knee agree very well, and probably represent quite closely the values that would be obtained for any of the deeper parts of the body. Since intensifying screens are ordinarily used only for radiographing deeper parts, the variation of intensifying factor with the part radiographed need scarcely be taken into account in practical radiography.

The possibility of using the *x*-ray sensitometer to measure the efficiency of an intensifying screen has been pointed out by Hodgson.[1]

Such a method admits of higher precision than practical tests, but the necessary conditions to be observed in a sensitometric method require a greater knowledge of the fundamental characteristics of intensifying screens than we have at present, if sensitometric tests of screens are to be of value for practical radiography. The con-

[1] Hodgson, M. B. The Sensitometry of Roentgenographic Materials. *Am. J. Roentgenol.* Dec. 1917, pp. 610-17.

ditions in sensitometry are usually different from the conditions of radiography. In sensitometric tests, a lower intensity of radiation is employed than is usual in radiography. In the sensitometer, the various densities are produced by the same intensity and quality of radiation acting for different times, while a radiograph is made by various intensities and qualities of radiation all acting for the same time. However, if the intensifying effect of a screen does not vary with the intensity and quality of the incident radiation, then sensitometric tests of screens should give the same results as practical tests.

Experiments were made to determine the validity of the ordinary sensitometric method of measuring the efficiency of intensifying screens.

In the *x*-ray sensitometer, one half of the film was backed by the intensifying screen, or in the case of a double screen, sandwiched between the two screens, the other half of the film being exposed without screens. Both halves of the film received the same series of exposures, which were accurately controlled by the sensitometer timing mechanism. After exposure, the film was given the standard development in an Elon-hydroquinone developer, and the resulting densities were measured. For each film, two sensitometric curves were plotted, one for the strip made with intensifying screens, and one for the strip produced by the *x*-rays alone. From these curves could be determined the exposures required to produce any given density either with or without the screen. The ratio of the exposure without screen to the exposure producing the same density with screen is the intensifying factor.

A large number of sensitometer tests were made with various screens and upon several photographic emulsions. Often the results obtained were quite different from those obtained with the same screen and emulsion using a live subject under the conditions ordinarily used in practical radiography. It was evident that the sensitometric method could not be relied upon to give correct intensifying factors. The result of the sensitometric tests of screens *A* and *B* are shown in Table II. The intensifying factors determined by the sensitometer are given for densities of 1.0, 1.5 and 2.0. In these tests the tube was run at 5-inch spark gap, 1 milliampere, at a distance of 128 centimeters from the film. Table III gives the results when the same radiation was filtered by 1.7 millimeters thickness of aluminum. These values should be compared with the intensifying factors for the same screens determined by making radiographs of various subjects as given in Table I. "Dupli-Tized" *x*-ray film was used in these tests, all the films receiving the same standard development as the practical tests reported in Table I.

TABLE II. SENSITOMETRIC RESULTS.

	INTENSIFYING FACTOR FOR DENSITY OF		
Screen	1.0	1.5	2.0
(A) Single Screen	1.75	1.57	1.48
(A) Double Screen	1.87	1.89	1.83
(B) Single Screen	1.70	1.64	1.52

TABLE III. SENSITOMETRIC RESULTS WHEN ALUMINUM FILTER IS USED

	INTENSIFYING FACTOR FOR DENSITY OF		
Screen	1.0	1.5	2.0
(A) Single	2.66	2.47	2.35
(A) Double	2.48	2.36	2.30
(B) Single	4.62	4.00	3.38

Upon comparison with Table I, the discrepancies are quite apparent between the sensitometric results and those obtained by making radiographs under practical conditions. Furthermore, for unfiltered rays, the sensitometer gives only a slightly higher factor for the *A* double than for the *A* single screen, and where an aluminum filter was used, the double screen was less effective than the single screen. In practice, it is found that the speed of the *A* double combination is faster than the *A* single screen by 50 to 75 per cent.

It has been noted by other observers that the intensifying factor of a double screen increases with *x*-ray intensity. To show this effect sensitometric tests were made in which the spark gap (5 inches) and current (1

milliampere) were kept constant, and the intensity varied by changing the target-film distance. The exposure times were varied inversely as the x-ray intensity, so that every sensitometer strip received the same series of x-ray exposures. The intensifying factors obtained in this way are given for various target-film distances in Table IV.

TABLE IV

		INTENSIFYING FACTOR FOR DENSITY OF		
	Intensity	1.0	1.5	2.0
Distance=D=130.8 cm.	1	1.59	1.62	1.63
Distance=$\frac{D}{\sqrt{2}}$= 92.5 cm.	2	1.88	1.88	1.84
Distance=$\frac{D}{2}$= 65.4 cm.	4	2.19	2.29	2.37

The same effect was tested by making radiographs of the wax knee with and without a double screen, using currents varying from 0.5 milliampere to 20 milliamperes, with target-film distance of 20 inches, and spark gap of 5 inches. In this experiment a constant intensifying factor was assumed, so that at every value of the tube current, the ratio of the exposures with screens to the exposures without screens was the same. At 0.5 milliampere the screened negative was less dense than the unscreened negative, showing that the assumed intensifying factor was too high; at 20 milliamperes, the screened negative was denser than the unscreened negative, showing the assumed factor to be too low. Thus the intensifying factor of a double screen was found to increase with increasing x-ray intensity. This effect, in part at least, accounts for the fact that higher contrast is secured with double intensifying screens than without screens; the higher densities of the negative are produced by the higher x-ray intensities, and receive relatively greater intensification than the lower densities. No doubt the agreement between sensitometric and practical tests of screens would be closer if higher x-ray intensities were used in the sensitometric tests.

The sensitometric method of measuring intensifying screens efficiently is essentially the same as the "step" method, described by Morrison.[2] In the sensitometer, a series of exposures is given to the screened portion of the film as well as to the unscreened portion; thus the intensifying factor can be determined for any density within the range of densities common to both halves of the film. In the step method as ordinarily used, but one exposure is given with the intensifying screen. The x-ray intensities generally used with the step method are higher than those of the present sensitometric tests and therefore should give results more nearly approaching those of practical tests. Our present form of sensitometer does not operate rapidly enough to make it possible to use as high x-ray intensities as are used in radiographic work; the construction of a high intensity x-ray sensitometer for use with a pulsating source of high potential offers considerable difficulty.

From the above experiments, it is concluded that at present the most reliable method of determining intensifying factors is by practical trial, using the kind of subject, spark gap, tube current, target-film distance and the photographic material with which the screen is to be regularly used.

The graininess of intensifying screens was estimated by a flash test, sufficient exposure being given to produce a half tone density with standard development of the film. It was necessary to secure firm contact between the film and intensifying screens; in case any of the screens were rather stiff, several thicknesses of blotter were loaded in the cassette behind the screen to increase the pressure. After development, the films were examined with a magnifier for graininess; where the graininess was at all bad, it was easily evident to the naked eye. Fig. 1 shows some photomicrographs of such tests for graininess.

Comparative tests of the primary definition given by intensifying screens were made by radiographing copper gauze

[2] Morrison, R. T. A Practical Method for Testing the Efficiency of an Intensifying Screen. *Am. J. Roentgenol.* Sept. 1910, p. 458.

meshes, such as are used by chemists. Primary definition is largely a function of the inherent screen graininess. Two such meshes were used, one having 67 spaces per inch and the other 200 per inch. A piece of each gauze was cut out to about one inch square and mounted in cardboard to keep it flat; for the test, it was laid upon the cassette or the cardboard holder containing the film. Precautions were taken to secure good contact between the intensifying screens and the film. The fine focus Coolidge tube was used, at a distance of 50 inches from the film, with 5-inch spark gap and 10 milliamperes. The exposures varied from ½ second to 1¼ seconds, according to the speed of the screens, and were adjusted to give a half tone density upon the film. The resulting negatives were examined with a small magnifier. Individual screens were found to vary considerably in excellence of definition. Photomicrographs of some of these tests are shown in Fig. 2. The definition of "Dupli-Tized" X-Ray film without screen is by this test markedly superior to the best screen definition. It should be borne in mind, however, that no scattering medium was interposed between tube and film. The 200-mesh gauze is well suited to such definition tests; the best intensifying screens show the meshes quite distinctly, while with the poorest screens, the meshes can scarcely be distinguished. These tests showed that somewhat better definition is obtained with a single screen than by the double combination; all the single screens except one were found better than any double screen combination. This factor of definition is being investigated further and the writer hopes to present at some future time the results of tests showing the efficiency—from point of definition—of various exposure techniques when scattering material is interposed between tube and film, thus approximating conditions of actual practice.

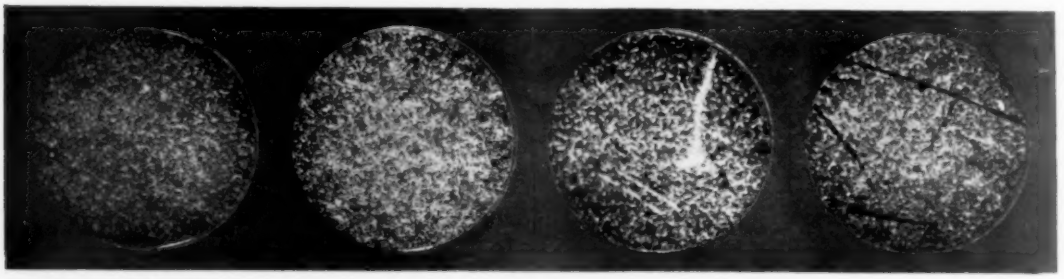
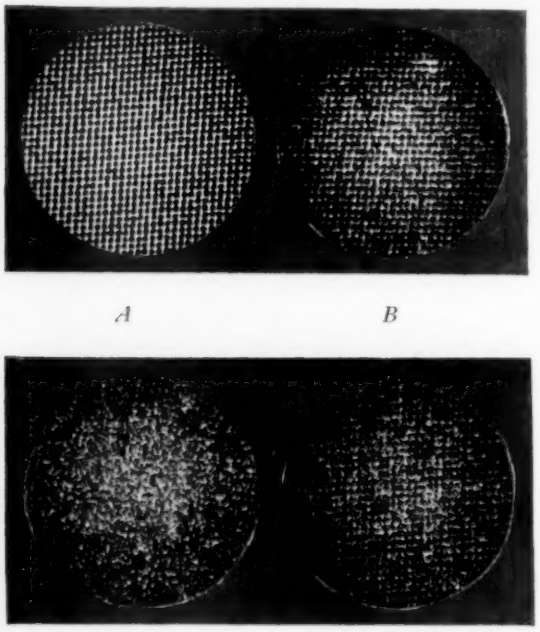


Fig. 1. Showing Graininess of X-Ray Intensifying Screens; Magnification, 9 Diameters.



A B C D

Fig 2. Primary Screen Definition Tests, with Wire Gauge of 200 Mesh per inch; no scattering medium between screen and tube. Magnification, 9 Diameters. *A*. X-Ray Film without Screen. *B*. Single Screen. *C*. Double Screen. *D*. Double Screen.

Further tests were made for variations in definition over different parts of the cassette, due to lack of contact between the screens and the film at some places. The method employed by Dr. Coolidge was used; a piece of copper gauze (67 meshes per

inch) covering the whole area of the cassette was radiographed. As in the previous tests, the fine focus tube was used at a distance of 50 inches. A cassette whose cover was held shut by a single strong spring pivoted at the center, was first used. A pair of moderately flexible screens were used in this cassette and the test showed the definition to be quite uniform over all parts except the corners, where the definition shaded off slightly. The definition at the corners was not improved by packing blotters in the cassette. The difficulty, therefore, was not lack of pressure, but uneven distribution of the pressure. The same pair of screens were tried in another cassette, whose cover was held shut by two rather weak springs. Better uniformity of definition was found in this case; the pressure was not as strong, but it was more evenly distributed.

Another pair of intensifying screens were also tried; these screens were very stiff and had a tendency to curl. The result was that very poor definition was obtained; improvement was effected by packing blotters in the cassette, but even then it was not satisfactory; in the case of the single spring cassette, the definition was fair in the central area but very poor near the edges and corners. The single screen was more easily held flat and gave good definition over the central area, shading off toward the ends and corners. To secure good uniformity of definition, it is necessary to have the screens fairly flexible; or, if they are stiff, they must remain flat with no tendency to curl. The cover of the cassette should be as rigid as possible, and the springs arranged to give an even distribution of the pressure.

SUMMARY

The writer believes that the following specifications should be considered in deciding upon the materials for use in screen technique:

1. SCREENS.—They should be flexible, of uniform multiplying factor from screen to screen, free from noticeable primary graininess and of good definition. The American screens generally used in this country as a rule fulfill most of these conditions.

2. CASSETTES.—They should give good contact all over the surface of the film or plate, as shown by wire screen test; they should be free from material which will shed lint and should have no tendency to accumulate aluminum or lacquer dust.

In order further to adapt films and plates for screen technique, the writer wishes to report that experiments are being continued toward this end. In view of the fact, however, that the present photographic materials are rather well adapted to the screen fluorescence a radical change is not to be expected without changing the material in the screen. It does not seem probable that any great change can be expected in this direction either.

In conclusion the desirability of either single screen or double screen technique seems to be a question for the decision of the individual. With the single screen a multiplying factor of five can be had, the definition is good, but there is no appreciable increase in contrast. With the double screen a factor of from three to five can be obtained, there is a slight loss in definition, but there is increased contrast and noticeable freedom from recording of scattered radiation. Where straight reduction of exposure time is all that is required, the single screen technique will probably be desirable. It will, however, be for the individual roentgenologist to decide whether the increased contrast and freedom from scattered radiation with the double screen method are worth the initial cost of the screens. Decisive tests of either method are comparatively simple to make. It is regretted that it is impossible to reproduce the negatives made in the foregoing investigation so that they would correctly illustrate the points brought out.

In conclusion the writer wishes to express his indebtedness to Mr. M. B. Hodgson for suggesting that these tests be made, and for helpful advice during the progress of the experiments. Mr. A. P. H. Trivelli very kindly made the photomicrographs of the definition and graininess tests.

RADIUM IN THE TREATMENT OF CARCINOMA OF THE CERVIX AND UTERUS

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A LARGE number of cases of carcinoma of the cervix and uterus in all stages have been treated by radium during the past five or six years, and the results obtained have been sufficiently good, so that the medical profession has accepted this method of treatment not only as a palliating agent, but as a curative measure. Its status is such now that many consider it one of the most valuable therapeutic agents we possess. As was to be expected, this method is drawing into the field many physicians without adequate training, and the poor results which follow the poor technique are bound to react; but this reaction will not be against the medium used, but rather against the user.

Unfortunately most gynecologists using radium are more familiar with carcinoma from the operative standpoint than the radiotherapeutic. It is just as necessary to develop a radium technic as a surgical, and for some time to come the best end results are bound to be produced by those who have studied every detail, checked up a large number of cases and compared them with a large series of cases treated by others. A great many cases have been treated by different physicians and surgeons, and since their method of applying the radium varies considerably, it is natural to expect that their end results, as well as the amount of palliation, vary considerably.

Until lately, only the hopelessly inoperable and recurrent cases were referred for radium treatment, but now we are getting border-line and more favorable cases. We should be careful not to make enthusiastic and unwarranted statements. Whatever the method of treatment of cancer, conservative statements and rather radical methods of treatment are advisable. Can a gynecologist give a prognosis from clinical history, pelvic examination, examination of tissues at the time of operation, or a pathological report? No! Then why should extravagant statements or promises be made in any given case?

Bailey states: "Experience has taught that removing the local lesion is not the most important factor in the operable case, and that in order to increase the number of cures our efforts must be directed towards the involvement, often impalpable and invisible, of the lymphatic tissue throughout the lower part of the pelvis. Hysterectomy, with the most extensive type of dissection and removal of the tissues of the parametrium, has been the effort in this direction, and although it is a procedure that carries a high primary mortality, it is a move in the right direction, and has been until now the only hope for these sufferers. Nevertheless the five-year cure period shows a discouragingly low percentage alive, and from a microscopical standpoint it must be admitted that even the boldest operator can hardly hope to remove all the lymphatic tissues about the base of the bladder, in the parametrium befond the uterus, or in the base of the uterosacral ligaments."

Then, since radium can destroy cancer cells which cannot be reached with the knife, it is necessary to develop the most efficient technic possible. Most of those who have treated a large number agree with Janeway, when he says: "Our present evidence indicates that radium destroys the disease at a greater distance than the knife is capable of removing it, and does this with no risk or inconvenience to the patient." Kelly states: "Recent studies have shown that in from thirty to fifty per cent of operative

cases of cancer of the uterine cervix, the disease has formed metastases into the pelvic nodes." Similar statements have been made by other surgeons. Since it is the general opinion that the removal of the pelvic lymph-nodes has very little curative value, we should develop an efficient method for radiating the lymphatics. Unfortunately we are unable by any clinical test to determine whether or not there is an extension into the pelvic lymphatics. Therefore, the only safe way to do is to ray the pelvic glands in all cases, regardless of the stage of the disease.

Recent studies have shown that there is no dependable relation between the size of the primary growth and the presence or absence of metastases. It has been stated that in forty per cent of inoperable carcinoma of the cervix the pelvic nodes are free from metastases. This would account for brilliant results in moderately advanced cases by radical hysterectomy and from local radium treatment with an even inefficient radiation to the pelvic lymphatics, because even local radiation properly given appears to destroy cancer cells at a greater distance than can be removed by a simple hysterectomy. Really, in any given case, we are unable to determine by any method of diagnosis whether the metastases have occurred in the glands or not, and the patient should receive the most efficient radiation possible to the lymphatic glands in the pelvis.

It has been stated that about seven or eight per cent of the cases of carcinoma of the cervix applying for treatment are free from cancer after five years.

Uterine cancer which arises in the fundus grows slowly, and usually does not extend beyond the uterus until late in the course of the disease. Operative mortality is low, with a high percentage of cures. Cancer which arises from the cervix runs a more rapid course, early invading adjacent tissues, and hysterectomy for carcinoma of the cervix is attended with a higher mortality and a large percentage of recurrences.

Cancer of the cervix is divided histologically into the squamous-celled and the cylindrical-celled or adeno-carcinoma. The squamous-celled type is the most common, and the adeno-carcinomas are more malignant, are usually situated in the cervical canal and are not diagnosed early.

Hysterectomies have been performed following radium treatment. In a large percentage of the cases within four to six weeks after radium treatment no cancer cells were found in the cervix, but in some instances there were traces of malignancy in the broad ligaments. This is an important fact, and is worthy of a very careful consideration by the gynecologist as an ante-operative procedure even in early cases, because it has been long known that we are never able to say positively that the lymphatics or adjacent tissues have not metastiasized.

The same holds true here as in cancer in other parts of the body, namely, that cutting out the center of a cancerous lesion never retards the disease, but that it is safer to operate after cell proliferation has been checked. If we consider that an operable case is one in which there is no extension of the cancer cells beyond the cervix, then two things will be accomplished by ante-operative treatment—destroying cells entirely and checking cell division, and the formation of productive inflammation to be followed by fibrosis. The first effect is obtained in from two to four weeks, but the fibrous formation will not take place until from four to eight weeks. In many cases of cancer of the cervix during this time there is a disappearance of cancer cells in the cervix and even to a considerable depth. It has been stated that this has been accomplished by the actual cautery; but it should be remembered that radium will destroy cancer cells at a considerably greater distance than heat.

When radium is used as an ante-operative procedure, the operation should be performed within from four to eight weeks before marked fibrous formation has taken place. Nogier claims that cancer cells beyond the reach of the knife often lie latent until after the operation, and that the operation seems to arouse the cells, and is followed by

recurrence. He advocates treating the local lesion, but especially the lymphatic glands, which he claims are ordinarily invaded. He believes the scattered cancer cells lose their power of reproduction after radiation, and that if any embolism occurs following the operation the embolus is sterile, and that there is not the same chance of cancer extension in the cases which have had ante-operative treatment. Finally, he claims the evidence is overwhelmingly in favor of radiotherapy followed by excision, as the logical treatment for cancer.

The results by the Wertheim operation in favorable cases correspond with statements which have been made by various authorities, that is, the early involvement of the parametrium or the lymphatics at the time of the operation, according to different observers, varies from thirty to sixty per cent. This would lead us to believe that only cases in which really no glandular involvement whatever has taken place were cured by a Wertheim operation alone, and that proper local radium treatment, supplemented by sufficient cross-firing from radium packs or the *x*-rays from outside as ante-operative precedure would cure many more cases. Then we may ask the question, should those who do the most radical operation subject their patients to a high operative mortality without giving them all the benefit possible from radiation, or until a larger percentage of cures takes place than has been reported by even the boldest surgical operators?

It is neither the occasional brilliant results nor the failures that count in work of this kind, but it is the correct analyses of all cases with full histories and a careful follow-up record that will give us the real value of this procedure. Hall believes that if uterine hemorrhage cases had radium early enough, there would be a great decrease in the number of uterine cancer cases.

Cancer of the cervix may be divided clinically into four groups, namely:

1. Early cases, where the growth or ulceration is limited to a part of the cervix and does not extend into the vaginal walls. Even in these early cases recurrences take place, and even metastases into the glands may have occurred before the operation.

2. Where the process is more advanced, and clinically the involvement is still limited to the tissues of the uterus because the organ is freely movable. Cases of this class may include cauliflower growths, which protrude from the cervix and often fill the greater part of the vagina. Even in these cases the cancer cells may not have reached the pelvic lymphatics. This is a class which will derive great benefit from ante-operative treatment, and by such procedure the end results should be better.

3. Where the disease is further advanced and the carcinoma extends into the vaginal wall. There is slight fixation of the uterus, but clinically there is not extensive involvement of the broad ligaments. If there is no glandular involvement, which we can never determine clinically (although, as before stated, the glands are often free in cases of this class), rather a high percentage may be clinically cured by radium treatment. Time alone will tell whether or not we should depend upon radium alone, even if we have obtained brilliant results by radium in a number of instances.

4. Cases of carcinoma of the cervix with marked fixation of the uterus, the disease extending into one or both broad ligaments with involvement of the vaginal wall, and a greater part of the cervix destroyed.

In many of these cases glandular involvement has taken place, and in some instances metastases have extended into the liver. These cases often will derive a great deal of benefit from radium, and a local or clinical cure frequently will take place. But even if metastases have been extensive the patient may remain free from cancer symptoms from one to three or more years. A cure might be effected, but with our present method of treatment we always expect the patient to die from metastases rather than look for a permanent cure.

When it is considered that about one-third of the cases of cancer of the cervix that

receive no treatment die within a year without an operation, that a large percentage of the remainder die within two years from the first manifestation of the disease, and that very few live three years, it is apparent that the amount of palliation and prolongation of life from radium treatment (and the fact that many of them die of internal metastases without return of the local symptoms), mean much to the patient. To-day radium is indicated as a palliative measure for hopeless inoperable and recurrent cases as an ante-operative precedure, and for prophylaxis after surgical removal. Lately radium is being used by some physicians for primary cases in carcinoma of the cervix when the disease extends into the cervical canal, because nearly all of those cases are followed by recurrence even in the early cases after operation. The malignant process in these cases will disappear by radium rather promptly. Time alone will tell whether radium without operation is advisable.

Radium is a specific palliative in operable cancer of the cervix and uterus. It will clinically cure some of the cases, and subjective improvement is noticed in a certain percentage of others. However, recurrence takes place in many of these clinically cured cases within two or three years. The patient during this interval regains normal health and can lead a useful life. If a recurrence takes place, as a rule the patient suffers little in comparison with those who had no radium treatment. In these hopeless cases, the offensive discharge and hemorrhage usually completely disappear within from two to four weeks. The cessation of discharge, which often is so offensive to the family and even to the patient, is a remarkable feature. The local condition changes in character within from two to four weeks after the treatment; the mass begins to contract and shrink, and continues to decrease in size. This is more marked in some instances than in others. The deodorizing and sterilizing effect of radium is very remarkable in the inoperable or recurrent cases where there is a broken down mass of carcinomatous tissue or a crater-like sloughing extending into the broad ligaments. These cases have a discharge with a very foul odor and run an irregular temperature. One application of radium will alleviate these symptoms and means much to the patient.

Dr. De Wayne Richey has written the following outline on histological changes:

"While the finer appreciation of the histological problems is complex, requiring a thorough understanding of the physical and chemical properties of both the radium and the neoplasm, a more or less superficial examination will demonstrate definite alterations in both the parenchyma and the stroma of the tumor tissue, after radiation. During the past decade or so, numerous contributions along these lines have appeared. The earlier of these noted the rôle of the connective tissue proliferation, even to the point of attributing the destruction of the malignant growth to it and regarding the disintegration of the tumor cells as secondary. Schottlander, in 1915, called attention to the early histological changes in the parenchyma, describing the vacuolar degeneration of the protoplasm and transformation of the chromatin as a specific action of radium. Two years later, Ewing mentioned the early hyperemia of radiumized tissues from the cervical canal, the swollen, homogeneous and hyper-chromatic nuclei, the hydropic vacuoles in the cytoplasm and the fusion of the tumor cells into giant-cell forms in the second week. Following this, a great reduction in the number of neoplastic cells, which appear to have suffered liquefaction, necrosis and compression by the proliferating stroma occurred, until, in the fourth or fifth week after the application of radium, only nuclear fragments or no trace remained.

"Recently Alter, in an exhaustive study of 275 cases of squamous cell cancer of the cervix uteri, confirms many of the findings of the earlier workers and again emphasizes the primary parenchymous involvement with the secondary replacement of the destroyed tumor cells by the ever-increasing

stroma. After the administration of radium, he noted a short latent period followed by inflammatory changes wherein is a marked histo-eosinophilia, along with, during the first week, the appearance of many young, engorged blood channels which penetrate the parenchyma and effect a separation of the epithelial cells. From the second week to the fourth or fifth week definite changes in the parenchyma begin as a swelling of the protoplasm and nuclei, which became pyknotic, progress through vascular degeneration, chromatin disturbances, loss of mitotic figures and dispersion of the protoplasm to the formation of fused chromatin masses, until in the ninth week, these end products of cellular destruction are pinched off into the irregular, small islands by the former cellular stroma which is now taking on hyaline, scar-like characteristics."

From Dr. Richey's statement it is observed that operation is favored in from four to eight weeks after the radiation rather than immediately afterwards. Treatment consists in the local application of either radium or *x*-ray, or both, through a number of ports of entry, directed towards the lymphatic glands which metastasize.

The local application of radium is carried out by most operators on a sounder basis than treatment given from the outside. It is quite generally known what a certain amount of radium will locally produce in a certain class of cases, because in three or four weeks the results of the treatment can at least be partly determined; but we have no method to visualize or palpate the adjacent pelvic or abdominal glands which have often metastasized even in early cases, nor can we determine by any clinical or diagnostic method whether the amount of cross-firing with either radium or the roentgen rays has destroyed the cancer cells in the lymphatics. There has been a controversy going on for the past few years as to whether this can be best accomplished by large quantities of radium or by the roentgen rays. No standard technique has been adopted.

In reviewing the work done by all those who treat carcinoma of the cervix by radiation, I am convinced that the amount of cross-firing done by nearly all, either by radium or roentgen rays, has been insufficient to destroy cancer cells at the desired depths, and many are obtaining very little effect except locally by radium. The treatment of the deep glands has been one which comparatively few of us have been studying during the past ten or fifteen years. Since we know that there are some cases of inoperable carcinoma of the cervix in which the pelvic glands have not been metastasized, some may think they are destroying disease in the lymphatics when there were no cancer cells present. In reality the clinical cure may have been produced by local application of radium, because it will destroy cancer cells at a greater distance than can be reached by the knife.

In a paper, "The Local Application of Radium Supplemented by Roentgen Therapy," read before the American Roentgen Ray Society, Atlantic City, September 24, 1915, I quoted Warnekros and concluded that if a growth was situated four inches below the surface it received about one-seventh of the radiation on the surface. This is probably nearly accurate; but from the work I have since done in the treatment of lymphatic glands in the neck, which later were removed and examined under the microscope, I believe it would require considerably more radiation than we would consider a safe erythema dose, using seven ports of entry, to destroy all cancer cells in the deep lymphatic glands, but most probably by using twenty or more ports of entry this can be accomplished. I have had lymphatic glands in the neck removed and examined after radiation and nothing but the fibrous stroma of the glands was left; but these glands were not situated so deep. The erythema dose must not be confused with the lethal dose. Many are confusing erythema (skin) dose with the amount necessary to destroy cancer cells in the lymphatics, because they have assumed tissue will bear several times the intensity required to destroy basal epithelioma without permanent damage.

During the last six years that I have been treating carcinoma of the uterus, I have used radium locally, supplemented by the *x*-ray or radium externally. From the beginning I gave rather large doses, in milligram hours, of radium locally, and used as many ports of entry externally as was practicable with *x*-rays. The last few years I have employed from three to four thousand milligram hours in the vagina, using one and one-half millimeters of brass, and sufficient gauze and rubber to make fifteen millimeters of filtration. Three tubes were usually employed, one directed towards the cervix and one towards each broad ligament. These tubes were packed as far as possible from the recto-vaginal wall, thereby lessening the danger of a fistula; and unless the uterus was fixed from the disease, the organs were pushed higher up in the pelvis by the amount of packing used, thus giving more efficient treatment to deeper pelvic glands. Each half inch treated means the same as a more radical operation. The importance of this has been overlooked by many and is undoubtedly one of the causes of producing an unnecessary fistula. Involvements of the rectum are nearly always late manifestations of the disease, and the amount of radiation the recto-vaginal wall receives is usually sufficient to destroy outlying cancer cells. The tissues of the cervix are relatively insensitive in comparison with other tissues of the body. It is important to bear this in mind, but we must remember that there is always a limitation to the amount of radium that can be used. Whenever it was possible by any means to insert radium into the cervical canal it was always done, because cancer cells thereby can be reached which could not be reached from the tubes in the vagina.

It has been stated that the therapeutic action extends from a radium tube along a radius of from two and one-half to four cm. —that is, Bumm and others claim that cancer cells are destroyed at this distance without permanently injuring healthy tissue in contact with radium tubes. Then if it is possible to use two or three tubes arranged end to end, this will treat therapeutically at a still greater distance than a tube placed in the cervical opening. However, the therapeutic action of the rays is reduced by absorption as the rays pass through the uterine walls; but if three thousand milligram hours (which is rather a large dose) are given in the cervical canal, cancer tissues at a slightly greater distance will be destroyed. I have given three thousand milligram hours where the disease was limited to the cervical canal, in addition to three thousand hours in the vagina, as described before, making a total local dosage of six thousand milligram hours. If this is given at one treatment it may not need to be repeated. The radium tubes in the cervix are filtered by one-half millimeter of silver, one millimeter of brass and from one to two millimeters of rubber. When six thousand milligram hours are given at one treatment, the patient usually has some discomfort afterwards, and the question of producing a fistula must be considered; but if we are going to treat primary cases without operation, rather heroic measures should be employed, and I am inclined to think that more is accomplished by a single treatment than to have this amount divided into two or more treatments. When such heavy treatment is given the cases should be properly selected and the tubes applied cautiously. It is difficult and impossible to employ the same technic in every case, as each presents variable factors. Lately I have been applying radium over the sacrum to treat the sacral glands, and in a few instances over the inguinal glands.

The following conclusions have been worked out in collaboration with Charles Viol, Ph.D., and thus reported by him:

CONDITIONS FOR THE PRODUCTION OF DEEP THERAPEUTIC EFFECTS WITH HARD *x*-RAYS AND GAMMA RAYS.

"In a paper by Sir Ernest Rutherford on the 'Penetrating Power of the *X*-radiation from a Coolidge Tube' in the September, 1917, *Philosophical Magazine*, the mass absorption coefficient in aluminum for *x*-rays excited at a voltage of 92,000 is given as

0.14 and the corresponding value for the gamma rays from radium—C is given as 0.026. For the *x*-rays, this represents the most penetrating rays excited at the voltage given, and that is, I am advised, about the highest voltage commonly used. Multiplying the given coefficient by 2.7, the density of aluminum, gives the absorption coefficient in one centimeter of aluminum, these values being respectively 0.378 for the hard *x*-rays, and 0.0702 for the hard gamma rays. With these two values for the absorption of the *x*-rays and gamma rays in aluminum as a basis, and setting the density of tissue as a unity, it can be estimated that the absorption coefficient for the two types of rays in soft tissues will be approximately 0.14 for the hard *x*-rays and 0.026 for the hard gamma rays. To obtain the thickness of the tissue necessary to absorb half of a given type of radiation when the absorption coefficient for that radiation in the given tissue is known, the mathematical relationship is that the half absorption thickness of the substance equals 0.6931 divided by the absorption coefficient. Therefore, with the above absorption coefficient for the hard *x*-rays and gamma rays it may easily be calculated that the *x*-rays will be half absorbed in penetrating through 4.9 centimeters of tissue of density I, whereas the hard gamma rays of radium will be half absorbed only if passed through 26.5 centimeters of the same tissue.

"In the application of radium energy to a deep-lying growth, such, for example, as in the attempt to ray malignant extensions in the broad ligaments and lymphatic tissue in advanced cervical carcinoma two factors come into play tending to reduce the intensity of the radiation which reaches the malignant tissue. The first effect is that of the divergence of rays, coming as they do from small sources which for convenience in calculation will be treated as point sources. The other factor is the partial absorption of the rays, which takes place on their penetrating through the tissue lying between the source of radiation and the tissue which it is desired to irradiate.

"In terms of a skin surface or erythema dose, we will calculate the intensity of the hard *x*-rays available at a point four inches below the skin surface when hard *x*-rays having the above described physical qualities reach the skin surface from a point eight inches away. On the basis of divergence of the rays, by means of the law of inverse squares, it may readily be shown that the intensity of the radiation four inches below the skin surface is reduced to 0.444 of the skin surface intensity and the four inches of tissue on the basis of the above given absorption coefficient will absorb 75 per cent of the *x*-rays, so that the intensity per unit area at four inches below the skin surface, in terms of the skin surface intensity as unity, will be 0.444 x 0.25=0.111.

"As already mentioned, there are two factors coming into consideration in this deep *x*-ray work, the first being the skin surface dose that can be borne without producing permanent damage, and the second factor is the lethal dose of the hard rays necessary to destroy the malignant tissue. At present we do not know the relationship between the skin surface or erythema dose and the lethal dose for malignant cells, the situation being further complicated by the fact that different types of malignant tissue are of varying responses to the action of the rays and it is not possible in every case to determine exactly the nature of the malignant tissue under treatment. If the skin surface dose were equivalent to the lethal dose for malignant tissue it would be clear from the above figures that the cross-firing of the malignant tissue through nine portals would be sufficient, since one-ninth of a lethal dose could be obtained through each portal. In practice, however, it is known that these two dosages are not equal, since far more radiation is required to destroy malignant cells; and consequently to produce results it becomes necessary to cross-fire through far more portals than nine. The preliminary report by Bumm and Warnekros on the 'Curing of Deep-lying Carcinoma by Roentgen Raying Through the Body Surface,' as reported in No. 29 of the *Muenchener Medizinische Wochenschrift* is the only one we have seen where it is claimed that the *x*-rays have been

able to influence extensively uterine carcinoma, and since this report is only a preliminary one, it, in itself, is hardly conclusive either as to permanency of results or as to the safety with which such enormous quantities of *x*-rays may be fired through the abdomen.

"In case of radium it would require quantities of radium at present unavailable were the radium to be placed as far away as eight inches from the skin surface. In practice it has been customary to use a number of radium preparations spread over a suitable area, thereby producing cross-firing, when it was desired to produce effects at any considerable depth.

"With a single tube of radium assumed to be point source one inch above the skin surface it follows that due to the divergence of the rays the intensity at a point four inches below the surface of the skin is reduced to 0.04 of the skin surface intensity, and due to absorption of the gamma rays in the four inches of tissue, the intensity is reduced to approximately 70 per cent of skin surface intensity, so that as a result of these two effects the available intensity of gamma rays four inches below the skin surface is approximately 0.03 of the skin surface intensity. It would therefore require approximately thirty-five times as long application of the radium under the above mentioned conditions to produce a lethal effect in the tissue at four inches below the skin surface as would be required to produce a lethal effect in the same tissue at the skin surface. Obviously such a lethal dose could not be administered by the use of a single tube of radium at a 1-inch distance from the skin surface, since while administering a lethal dose at a 4-inch depth too destructive an action would be produced in the intervening tissues.

"When radium is distributed over a surface to produce a so-called plaque effect, a better utilization of the rays is possible. So, for example, with the same amount of radium distributed uniformly over a square 6 inches on a side, the intensity of rays at 1 inch from the radium plane is only one-fifth that which the same amount of radium would give when the radium is collected in a single point. With the radium distributed as indicated, the ratio of the skin surface dose, 1 inch below the radium plane, to the dose received by the tissue four inches below the skin surface, is practically 8 to 1, which corresponds to the ratio for hard filtered *x*-rays as given above.

"Schmitz (*Surg., Gynec. & Obst.*, Aug., 1916), has shown that fifty milligrams of radium applied for twelve hours kills carcinoma cells to a distance of one centimeter.

"As showing about all the radiation that the skin will safely bear, Boggs reports the use of 315 milligrams of radium spread over an area of approximately 9 x 10 centimeters at 3 centimeters from the skin surface for fourteen hours. This is a total dose of 4,410 milligram hours. Assuming for convenience that this radiation comes from nine points, centers of rectangles 3 x 3 1/3 centimeters into which the large area is divided, each center therefore is the source of 490 milligram hours of radiation. Having in mind the lethal dose for carcinoma as given by Schmitz, (600 milligram hours effective to 1 centimeter) and taking this as the unit dose, with the above mentioned distribution, the skin surface intensity is 0.371.

"The maximum skin surface dose which can be given without producing serious burns, i.e., the skin erythema dose, is approximately 40 per cent of the lethal dose for carcinoma cells. This result hardly seems to accord with the belief that the carcinoma cells are so much more readily destroyed than the cells of the normal skin; however it must be borne in mind that a truly destructive skin dose has to be avoided, since if the skin reaction produced is too severe, the repair is very slow and the burn painful. It can only be pointed out, however, that the Schmitz results are based upon histological findings on nodules excised ten days after raying, and it is probable that destruction of malignant cells at a greater distance than 1 centimeter would have been observed after 600 milligram hours of radiation, had the action been allowed to go on for a month, at least, before excising the nodule."

ROENTGENOTHERAPY IN MALIGNANT DISEASE WITHIN THE ABDOMEN, WITH REPORTS UPON THIRTEEN CASES*

By GEORGE E. PFAHLER, M.D.

PHILADELPHIA, PA.

I WILL omit any reference to cases of uterine carcinoma, since in these I use both radium and the roentgen rays. Dr. Boggs will discuss that phase of abdominal carcinoma.

Malignant disease within the abdomen, especially if it be primary carcinoma, should be operated upon if there is a reasonable hope of complete removal, and this operation should be followed immediately by active deep roentgenotherapy. The treatment of malignant disease within the abdomen is most discouraging no matter what form of treatment is used. Most of the patients that are referred for roentgenotherapy are either the hopelessly inoperable, the recurrent, or those showing metastasis. Until recently there has been no reasonable hope of curing any of these. The surprising results which I have obtained in a few cases lead me to make this report, but we must always keep in mind, and impress upon the physicians and friends of the patient, that the great majority of these patients will die of the disease no matter what we do. The brilliant result occasionally secured in a patient in whom the disease is far advanced should make us cautious in our prognosis.

Four of these thirteen cases were previously reported before the American Roentgen Ray Society in 1917. These will be briefly reviewed here.

CASE 1. Mrs. J. B., age 47, was referred by Dr. John B. Deaver, October 30, 1907. One and one-half years before Dr. Deaver operated and found the entire omentum involved by tumor tissue. The case was inoperable and he made no attempt at removal of the tumor. He released some of the adhesions which seemed to be producing intestinal obstruction, but advised against any further operation. The patient's general health was good. There was general abdominal tenderness, especially in the hypogastric region and right iliac fossa, plus increased resistence in the latter. She received nine fractional doses during a period of two weeks. Crossfiring was used from two sides of the abdomen only, and the total dosage amounted to one erythema dose over the entire abdomen. She returned February 18, 1908, because of increased pains and symptoms of slowly developing intestinal obstruction. At this time there was a distinct mass to the left of the line of incision and considerable tenderness over the abdomen. Another course of treatment was given consisting of eleven doses, on each side of the abdomen, amounting to one full dose as we speak of it today, since only this amount of crossfiring was used. She returned for another course of treatment June 15, 1908, having had no symptoms of bowel obstruction during this interval of three months. The general tenderness had practically disappeared. The circumference of the abdomen was two inches less than at her previous visit, and the patient looked well. She returned again November 6, 1908, saying that she had been wonderfully well all summer. The abdomen was generally soft. Five fractional doses were given within ten days. She reported for examination October 11, 1912, apparently entirely well, said that she never felt better in her life; and, so far as she or I could tell, she was in perfect general health. On January 20, 1914, she returned, at the advice of Dr. Deaver, for further treatment. At this time she had no definite symptoms, but treatment was given as a precaution against development of the disease. General crossfiring was now used, according to our modern methods. The pa-

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tient seemed to be in good general condition. She was told to go home (for she lived about 200 miles from the city) and to report if any unfavorable symptoms developed. I received Christmas messages during the two succeeding years, but no complaints.

Remarks.—In a sense this is an unsatisfactory report because we had no microscopical study, but the disease corresponds so closely to the other cases reported that I feel it can be included. The patient lived in reasonable comfort during a period of eight or nine years.

Case 2. Mrs. D. MacF., age 57, was referred by Dr. Laura S. Chapin, December 8, 1913. This patient was operated upon by Dr. Barton Cook Hirst, May 18, 1913, nearly seven months previously, at which time nothing was removed, because all of the intestines were matted together by malignant disease. The patient was sent to us for treatment for the relief of pain because, at that time, only large doses of morphine gave her relief. The attending physician had no hope of relieving the disease. A course of twenty doses was given, according to modern technique, over the entire abdomen. At the end of a week she expressed herself as feeling very much better, was able to sleep without opiates, and her bowels moved without purgatives. There was some dermatitis after the first course of treatment and, therefore, the second course of treatment was not begun until April, at which time the improvement was very marked, the entire abdomen being soft; only a small palpable mass was found in the lower left groin. The third course of treatment was given during the latter part of May and the early part of June, 1913. At this time all the disease had disappeared excepting a small mass in the lower left groin. Treatment to this area was given, consisting of four doses, March 31, 1914 and August 31, 1914. She was examined by Dr. Hirst on June 26, 1914, at which time Dr. Hirst could find no evidence of the disease except for a small mass about the size of a hen's egg in the lower left groin. He expressed himself as being surprised and delighted with the results. The patient had also been examined by Dr. Wm. L. Rodman and Dr. Stillwell Burns on March 6, 1914. We all found the abdomen soft, except for this mass in the lower left groin, which was about the size of a hen's egg. Her bowels moved regularly without purgatives. She was free from pain and her general health was good. She neglected to come for treatment or observation after this, and on September 21, 1915, Dr. Samuel H. Brown reported to me that she had died of tumor in the brain. The latter was found at autopsy. The autopsy also showed a sinus of the abdominal wall, ptoses of the transverse colon and hernia, intra-abdominal adhesions, chronic interstitial nephritis, traumatic ventral hernia, adenocarcinoma (medullary) of the sigmoid, and metastatic carcinoma (medullary) of the frontal lobe of the brain on the right side.

Remarks.—As a result of the deep roentgentherapy in this case, the patient lived in reasonable comfort for about a year, and certainly lived a year longer than she would have otherwise. She finally died of metastatic disease in the brain, and not from the disease in the area in which the treatment was given. While in the end the case was a failure, the improvement in her general condition, her general comfort, her relief from pain, and the disappearance of the palpable disease, would lead one to believe that, had she been treated at a time when the disease was reasonably localized, she might have recovered completely.

Case 3. Mrs. J. E. L., age 51, was referred by Dr. E. P. Zeisler of Chicago, Ill., and Dr. C. V. Warner, of Miami, Oklahoma, July 6, 1916. During October, 1915, Dr. Eddie Meyer of Buffalo operated for ascites and obstruction of the bowel. This was found to be caused by a pedunculated ovarian cyst that had become wrapped around the gut. He diagnosed the condition at operation as cyst and peritonitis. In four months she again became filled with ascites, and upon operation at this time, Dr. Meyer found the abdomen filled with

colloid cancer. The pathological report by Dr. Charles A. Bentz is as follows: "The tissue examined consisted of two Fallopian tubes and a piece of omentum. The histological findings are papillary carcinoma of the tubes, with metastasis in the omentum." At the time when treatment was begun, the abdomen was firm. Avidness was complained of, and there were signs of fluid. A course of nineteen doses was given within four days, after which she returned to her home. There was no appreciable improvement at the end of a month, though, according to our original plans, a second course of twenty doses was given. After this she improved very much, though she was nauseated and prostrated following the second course of treatment. She returned for a third course of treatment on October 3, 1916. Her general health had improved, the abdomen was soft, there was no palpable disease, and no clinical evidence of disease whatever in the abdomen. She returned for the fourth course of treatment on December 11, 1916, at which time she appeared to be entirely well. Twelve doses were given in this fourth series, and she was sent home with instructions to report if any symptoms whatever developed, for we believed her to be well. On May 17, 1919 the patient called at my office for examination. The abdomen was normal in every respect. She had a small lymph node in the left supraclavicular region, the origin of which was obscure. We made an examination of the chest, but could recognize nothing abnormal. I advised that this lymph node in the left supraclavicular region be removed and examined microscopically, but up to the present time I have had no report upon the case.

Remarks.—This means that a patient who had had an exploratory operation at which a diffuse colloid carcinoma of the peritoneum was found, the latter having produced ascites in October, 1915, which was inoperable recovered under roentgentherapy and has remained well for approximately four years since treatment.

Case 4. Dr. X. was referred by Dr. Wm. J. Mayo on June 13, 1916, for treatment of general carcinosis of the peritoneum. The patient was operated on May 25, 1916, by Dr. Wm. J. Mayo. Under date of June 6, 1916, Dr. R. D. Carman of the Mayo Clinic wrote: "The *x*-ray examination showed a high cecum and slight filling defect in the sigmoid. These findings were thought to be due to an extrinsic tumor which is palpable in his right iliac fossa. He was explored by Dr. W. J. Mayo, who found a general peritoneal carcinomatosis of unknown origin. The abdomen contained free fluid and great masses of colloid material attached to the peritoneum, omentum, etc. Microscopic section showed carcinoma." Upon the patient's arrival for roentgentherapy there was evidence of free fluid in the abdomen. There was a tumor in the right lower abdomen about the size of a large grapefruit, firmly adherent, with general firmness of the abdominal tissues. He gave a history of having had an attack of appendicitis six years previously, but no operation. Three to four years ago he noticed a swelling in the right iliac fossa. About three months before coming for treatment this tumor, which had grown progressively larger, began to give pain, and obstructive symptoms were noted. He was given a course of deep roentgentherapy, through twenty portals of entry within two days. After this course of treatment he was nauseated; pain was reported in the abdomen, and his temperature rose to 101, pulse 105. He returned for a second course of treatment on July 5. At this time the tumor was only about two-thirds its original size, though he suffered from pain in the epigastrium. The second course of treatment was given within five days. He returned, on August 7, two months after treatment was begun, weighing 157, his weight before the operation was 170 to 177. Improvement in general appearance was noted, but the patient complained of getting tired very easily. The abdomen was softer and the tumor had decreased in size. A third course of twenty doses was given within three days' time. The fourth course was given from September 8

to September 14, 1916, after which he returned to his home in St. Louis, where he was under the treatment of Dr. Ernst. On October 7, 1916 the patient writes: "Feeling very well. Weight 162 pounds. Very little pain in the abdomen, though mass seems as large as ever." He was treated on an average of once a month by Dr. Ernst until July, when Dr. Ernst left for Europe. On August 9, 1917, more than a year after treatment was begun, the patient called to see me. At this time he looked perfectly well, had gained in weight, and had been attending to his practice since February, 1917. Palpation of the abdomen showed nothing abnormal except a slight induration in the right groin along Poupart's ligament, which did not have the feeling of a mass, but only of increased firmness.

Remarks.—This patient, who was considered inoperable and in my judgment was hopeless when he first called upon me on June 13, 1916, has recovered his health, has returned to his practice and has visited me each summer, at which time we found his abdomen soft. During the past year he has had some enlargement of the liver and some suspicion of a recurrence of the disease. In July, 1919, at his visit, we gave him a course of treatment over the abdomen and liver, and on December 20, 1919, he wrote as follows: "I am about the same as last summer. Weight 148. Have had two series of *x*-ray treatment from Dr. Ernst. Eat and sleep well and feel fine." No matter what the future outcome in this case may be, the patient has certainly had his life prolonged by four years, with the hope of many more years; and at the first visit he was as hopeless as any patient I have ever seen.

Case 5. Mr. W. K. S., age 50, was referred to me by Dr. W. S. Bertolet, June 16, 1916, on account of severe stomach trouble and attacks of severe pain in the abdomen. Dr. Bertolet suspected obstruction of the bowel. By *x*-ray examination I found evidence of a carcinoma filling the transverse colon at a point about 2 inches proximal to the splenic flexure, the lumen being reduced to about ¼ inch. On the night following my examination he developed signs of intestinal obstruction. Dr. Chas. Nassau was called during the night to operate, and resected the carcinoma. He was then sent to me for post-operative *x*-ray treatment. From July 14, 1916, to July 19, 1916, we gave him 16 doses through 16 portals of entry, crossfiring as much as possible in the region of the operation. A similar course of treatment was given in August, September and October, 1916, at which time he was free from symptoms. He returned from time to time for examination. On June 19, 1917, or a year after the original operation, he returned for examination. At this time I found some evidence of constriction at the same location in the bowel. I was unable to decide whether this was malignant, or a contraction of the scar tissue, and therefore gave him another course of treatment, making five courses in all. He has had no treatment since.

Remarks.—The constriction which was noted in June, 1917, has practically disappeared, and at the examination on October 22, 1919, the lumen is restored to practically normal size. He is still in excellent health to-day, three and a half years after operation and post-operative *x*-ray treatment was begun.

Case 6. Mrs. W. L., age 50, was referred to me by Dr. J. B. Roxby, on April 4, 1916, for examination. At this time I found a very advanced and extensive carcinoma of the rectum. The patient was operated upon by Dr. Wayne Babcock on April 11, 1916, at which time he resected the diseased area including most of the rectum, and did a posterior colostomy. She was given 19 doses of *x*-rays between May 11 and May 15, 1916, through 19 different portals of entry, crossfiring chiefly in the location of the former disease. This treatment was repeated in June, August, September and November, 1916, at which time she appeared to be entirely well. She received 11 doses in January, 1917, 8 doses in March, 1917, and 19 doses in September, 1917, at which time she seemed to be well. She re-

ceived 12 doses in February, 1918. At this time she had no abdominal symptoms. In April, 1918, she developed stomach symptoms; a mass was found in the epigastric triangle the size of an orange. This, Dr. Roxby believed, was carcinoma. At this time the patient took up Christian Science treatment, and died April 24, 1918.

Remarks.—This patient died of carcinoma of the stomach, and while she is a failure in that sense, she did not have a recurrence of the disease in the region in which she was operated upon, and in the region in which she received post-operative treatment. When one considers the likelihood of recurrence of carcinoma in the operative field (in this case carcinoma of the rectum), we must look upon this as at least, a partial success.

Case 7. Mr. H. A., age 31, was referred to me by Dr. Wayne Babcock, on February 4, 1915, for post-operative treatment. Three weeks previously he had resected 10 inches of the sigmoid on account of carcinoma, and at the same time removed a number of metastatic lymph nodes. We divided the abdomen into 36 areas crossfiring so far as possible, on the region of the sigmoid, but really covering the entire abdomen. This was repeated at an interval of a month, and again at the interval of the second month, so that in all he had three such series of treatments. Following this he got entirely well and has remained so for almost five years.

Remarks.—We know how rarely these patients with extensive carcinoma of the bowel (especially in a young person) associated with metastasis, are cured without this combined form of treatment, and I believe that we can attribute this brilliant result to the post-operative *x*-ray treatment following a skillful operation. A roentgen study made two years later showed that the lumen of the bowel in the sigmoid was practically normal. He has remained well for approximately five years.

Case 8. Mr. J. J. L., age 38, was referred to me by Dr. Wm. J. Mayo on December 14, 1917. Dr. Mayo had operated on account of a palpable tumor in the left hypochondriac region and found a large carcinoma involving the transverse colon at the junction of the middle and left third. It was irremovable on account of its being attached to the superior mesenteric artery. My examination of the bowel showed a mass occupying approximately 6 inches of the transverse colon, and reducing the lumen of this transverse colon to less than 1/3 normal over an extent of about 3 inches. We began active *x*-ray treatment and gave him 38 doses through 38 different portals of entry in the first series of treatments, between December 12, 1917 and December 20, 1917. A second course of 31 doses was given between January 18 and January 20, 1918. In February, 1918, a re-examination showed that the lumen of the bowel had increased, the tumor tissue had been reduced to about half. The patient's general health had improved, so that upon meeting him no one would have thought he was sick. He had gained 6 pounds in weight. He received a third course of treatment in February, a fourth course in April, a fifth in May, and a sixth in August. At this time he began to fail. The examination of the bowel then showed what I believed to be a perforation and communication between the large and the small bowel. He developed diarrhea and died on September 21, 1918.

Remarks.—This case is, of course, ultimately a failure, but we undoubtedly elicited some response even in this very advanced stage of the disease since, when he first came, he was most cachectic and the treatment was only undertaken as a sort of "last straw." The encouraging thing is that two months later his general health had improved to such an extent that one would have considered him well in looking at him, and that the tumor showed undoubted reduction in size. This proves that, even in these abdominal carcinoma, the *x*-rays can produce a distinct effect. The chief advantage of such observation is to prove that the rays will destroy carcinoma cells within the

abdomen. Therefore, there is a distinct value in post-operative *x*-ray treatment, and perhaps some hope in the inoperable cases.

CASE 9. Mr. J. C. L., age 48, was referred to me by Dr. Ernest Laplace on April 28, 1914. Three years previously he had about one foot of the large bowel resected on account of carcinoma which had caused acute obstruction. The patient was in a state of complete collapse at the time of the operation, and an inguinal colostomy was done. The colostomy was closed about five months before coming to me. Since that time small excrescences had formed about the wound, surrounding which were extensively indurated tissues caused by recurrent carcinoma. He was given *x*-ray treatment over this area. The disease became more fibrous and more definitely isolated. On October 23, 1914, at my request, Dr. Laplace excised the whole indurated area. The patient was then given four doses as a post-operative measure. Treatment was not repeated until March 9, 1915 when he was given four doses over this area. A year later there was evidence of recurrence. We treated this area twice during 1915. Then he seemingly remained well for about two years. He returned November 27, 1917, with a distinct recurrence. The patient received one course of four doses on December 27, 1917, four doses January 21, 1918, another course of four doses on February 18, 1918, and on May 1, 1918 another course of four doses was given. At this time there was an improvement in the carcinomatous condition. The patient remained away until July 24, 1918. At this time his general condition had improved, and he was attending to business regularly. On September 16, 1918 he returned with evidence of new growth and was referred for operation to Dr. Mantz, who excised the entire area. He received one course of post-operative treatment consisting of four doses, but the disease extended, and he died May 11, 1919.

Remarks.—In a sense this is also a failure because the patient died. Yet from the time of the first treatment on April 28, 1914, to his death, May 11, 1919, a period of five years elapsed, and I feel that the rays had undoubtedly retarded the growth.

CASE 10. Mr. B. E. C., age 53, was referred to me by Dr. J. E. Hardy of Waterville, Maine, June 4, 1919. Six weeks previously he had an exploratory operation done on account of severe pain in the right iliac fossa. An advanced and inoperable carcinoma of the cecum was found. Occult blood was found repeatedly in the stools, even before the operation. The tumor was the size of a lemon, and there was involvement of the appendix, and the wall of the bowel, with enlarged glands in the neighborhood. No attempt at removal of the tumor was made, and no section was taken. *X*-ray treatment was begun on June 7, 1919 and 21 doses were given, crossfiring chiefly in the right iliac fossa. This was repeated in July and again in August and September, at which time the induration had greatly decreased and the general health seemed to be good. The patient has returned to Maine to teach school for the winter.

Remarks.—Only a short period has elapsed, of course, since beginning *x*-ray treatment, but nothing was done for this man excepting the *x*-ray treatment, and his improvement in general health and the decrease in the size of the tumor must be accredited to the *x*-rays. Under ordinary conditions he would have grown worse instead of better. He has returned to his occupation as a school teacher.

CASE 11. Mrs. R. M. F., age 31, referred to me by Drs. H. G. Anderson and C. H. Brown of Waterbury, Conn., August 8, 1919. In the latter part of June this patient was taken suddenly ill with cramps in the abdomen. The patient was taken to the Waterbury Hospital and an exploratory laparotomy done by Dr. H. G. Anderson, at which time an inoperable carcinoma involving the small intestines and mesentery was found. About 12 inches of the intestinal

mass was removed. The growth was adherent to the surrounding structures. She had two *x*-ray treatments by Dr. Brown in Waterbury. When she arrived at my office for treatment examination showed a palpable, irregular and indefinite mass, with marked increased resistence on the left side of the abdomen over an area eight by six inches. She was cachectic, weak, and had all the appearances of an advanced carcinoma. *X*-ray treatment was begun on August 12, 1919. At this time she was markedly constipated. One month later her bowels were moving without any laxatives, and she was beginning to do her general housework, which gave her some pain in the left side. Excepting for one day's pain, however, she was entirely free from her former symptoms. A second course of *x*-ray treatment was given. She only had two courses of *x*-ray treatment, each consisting of 15 doses. On November 18th she called for examination. She looked perfectly well and felt perfectly well. Examination of the abdomen showed no induration or conditions to suggest disease. There was no dermatitis present, and to all outward appearances, she has been cured.

Remarks.—This is one of the most remarkable results I have seen because of the prompt improvement. Unfortunately no section was taken at the time of the operation because there seemed to be no doubt as to diagnosis and a removal of a section seemed to be dangerous. She has only had two courses of *x*-ray treatment since I saw her. From a cachectic, emaciated woman, in three months she was restored apparently to normal health, and is attending to all her household work.

Case 12. Mr. G. L. H., age 41, was referred to me by Dr. Edwin Fiske, March 9, 1918. In October, 1916, he had had the right testicle removed on account of carcinoma. This had been developing for 11 months. The pathological report from the Higgins Laboratories, New York, stated: "Carcinoma with secondary inflammation." In this case I secured the specimens removed from the testicle and referred them to my friend, Dr. E. Case, who confirmed the diagnosis of carcinoma. Two months before coming to me the patient discovered a large mass in the upper part of his abdomen. At the beginning of my treatment, in March, 1918, he had a tumor involving the upper part of the abdomen which was approximately the size of his head. The first course of *x*-ray treatment, consisting of 33 doses, was given between March 9th and March 30, 1918, crossfiring upon this tumor. He returned in April for a second course of treatment, at which time the tumor was reduced to about the size of a large orange. This time 23 doses were given. He returned in June for a third course of treatment. At this time he looked well, felt well, and we found the tumor approximately the size of a hen's egg. A fourth course of 22 doses was given in July. At this time further reduction in the size of the tumor was evident. A fifth course was given consisting of 10 doses during October 1918. A sixth course was given in January 1919, consisting of 7 doses. A seventh course was given in April 1919, consisting of six doses. An eighth course consisting of four doses was given in July 1919, and a ninth course consisting of four doses was given in October 1919. At this time the tumor had practically disappeared. There was still a faint resistance which would not have been discovered had it not been known that a tumor had existed there. The patient now reports himself as well.

Remarks.—During all this time, from the beginning of treatment, he continued his occupation as a school teacher. He is teaching school to-day, and is to all outward appearances, perfectly well. This is due to *x*-ray crossfiring upon the deep-seated malignant disease within his abdomen, and this disease, to all outward appearance, was a secondary carcinoma within the abdomen due to primary carcinoma of the testicle.

Case 13. Dr. W. D. B., age 43, was referred to me by Dr. Wm. H. Kraemer of Wilmington, Del., Octomer 24, 1917. In January of this same year he first noticed a

tumor about the size of an orange slightly to the right in the lower epigastric region. He also had an enlarged right testicle. An *x*-ray study showed the chest normal. The tumor was found not to involve the gastro-intestinal tract. It was lying back of the bowel and according to my report was "either a part of the right kidney or a tumor lying over the right kidney. Would suspect either possible sarcoma or hypernephroma of the right kidney. Examination of the right testicle by the *x*-rays showed three calcareous deposits." I advised operation, but this was not done until April 1, 1918, when Dr. Draper opened the abdomen and found a retroperitoneal mass which could not be removed. The testicle was removed, but unfortunately was lost before a microscopical examination could be made. During the latter part of March, 1919, he was seen in consultation by Dr. J. Chalmers DaCosta, who made a diagnosis of retroperitoneal tumor, probably sarcoma. A Wassermann test was made which was negative. He was referred to me for *x*-ray treatment on April 1, 1919. This tumor had been growing especially rapidly during the previous month. Dr. DaCosta had advised against further exploratory operations. When he was referred to me I made another *x*-ray examination and found no evidence of sarcoma within the chest, but the abdomen contained a number of large abdominal masses varying in size from an egg to a fist. The patient was given 19 doses of *x*-rays in April in his first course of treatment. In May he was given a second course of treatment consisting of 19 doses. In June he was given a third course of treatment. The tumor suddenly diminished in size. His general health improved. In July he was given a fourth course of treatment. At this time there was only slight hardness present in the region of the largest tumor. In August he was given a fifth course of treatment consisting of 15 doses, and in October he was given a sixth course of treatment consisting of 8 doses, at which time no palpable tumors could be found. His general health was good, and he was working every day on a railroad. He has been seen this week, and is the picture of health. He is still working every day.

Remarks.—This case seemed to be a rather hopeless and certainly inoperable one at the beginning of treatment, and seemingly was suffering from metastatic malignant disease secondary to malignant disease of the testicle. This disease was discovered in the abdomen even before the primary operation on the testicle. Under treatment his general health improved, the tumors gradually disappeared, and he has been restored to complete health. The outcome can, of course, not be definitely stated at this time.

A future report on these cases I believe will be justified.

TECHNIQUE

In the treatment of these patients the aim should be, of course, to cover the entire abdominal cavity, including the liver, and there should always be an *x*-ray examination of the chest to see whether the disease may have spread there. In none of these cases was there any evidence of metastasis in the chest. The abdomen is divided into from twenty or thirty areas so that every part receives treatment anteriorly and posteriorly. Most of the treatment, however, should be given anteriorly, because of the greater facility in reaching the disease, and the greatest crossfiring should be upon the location of the primary disease.

With our outfits we have been using 40 milliampere minutes, with a focal distance of 8 inches, and with a constant voltage equivalent to a 9 inch parallel spark gap. These rays should be filtered through 6 millimeters of aluminum or glass. I believe that, generally speaking, it is inadvisable to crowd the treatments as close together as had been done in these cases reported, for one is very likely to bring about constitutional symptoms in the form of nausea and prostration. At least a week to two weeks should be used to give such a course of treatment. If this plan is followed, nausea

and prostration should be eliminated. This group of patients require the most serious attention and the greatest amount of skill. It is not work that can be turned over to a nurse or technician or amateur roentgen-therapist.

CONCLUSIONS

1. General carcinomatosis of the peritoneum will sometimes yield remarkably to the influence of deep roentgentherapy.

2. The prognosis, however, must always be most guarded, because this is metastatic carcinoma, and as such is liable to make its appearance elsewhere in the body, even though marked response is obtained from abdominal treatment.

3. Colloid carcinoma appears to be more responsive to roentgentherapy than other forms of abdominal carcinoma.

4. Post-operative treatment should be given in all cases of carcinoma within the abdomen.

5. Some cases of inoperable carcinoma of the bowels show improvement.

6. Abdominal metastatic carcinoma or sarcoma following malignant disease of the testicle disappears in some cases.

BOOK REVIEWS

REVIEW OF THE CHICAGO NUMBER of the *Medical Clinics of North America,* July, 1919. Volume 3, No. 1.

In reviewing this number of the *Medical Clinics of North America,* it is noted that the surgeons and physicians of Chicago take a keen interest and realize the important aid that roentgenology furnishes. This is illustrated by the following papers: Clinic of Dr. Frederick Tice, Cook County Hospital, A Mediastinal Tumor, p. 19. Carcinoma of the Stomach, p. 25. The latter case is of interest in that the autopsy revealed the presence of two metallic foreign bodies in the stomach wall which were not seen during the *x*-ray examination. Clinic of Dr. Milton M. Portis, Cook County Hospital, An Unusual Case of Carcinomatous Metastases in Bones Secondary to Carcinoma of the Stomach, p. 35. This case is of especial interest, because the patient gave absolutely no symptoms referable to the stomach. The roentgenographic findings, however, showed that the bones, namely the lumbar spine ilium and ribs, showed definite evidence of disease, which similated metastatic new growth. This proves that metastatic carcinoma of the bony skeleton is not always the result of carcinoma in the prostate, as has been emphasized for some years.

In the clinic of Dr. Julius H. Hess, Cook County Hospital, on the Radiographic Diagnosis of Bone Affections in Infancy and Childhood, p. 31, there are many points of special interest. Dr. Hess's paper takes up very minutely and ably the differential diagnosis between osteogenesis imperfecta tarda, rachitis, scorbutus, tuberculosis, osteomyelitis, both acute and chronic, sarcoma, acute infective periostitis, and syphilis.

Other papers of interest are: Carcinoma of the Esophagus Treated with Radium, p. 63; Syphilitic Periostitis of the Humerus, p. 205; Pulmonary Abscess Following Tonsillectomy, p. 209; Irregular Placement and Fixation of the Large Bowel, p. 253.

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TWENTY-FIRST ANNUAL MEETING

The Twenty-first Annual Meeting of The American Roentgen Ray Society will be held at Rochester, Minn., and Minneapolis, Minn., September 15, 16, 17 and 18, 1920; at Rochester on the 15th, at Minneapolis on the 16th, 17th and 18th.

Further details and advance information concerning the meeting will appear in these columns from month to month.

Minneapolis headquarters, Hotel Radisson.

MEETING OF MIDDLE SECTION AMERICAN ROENTGEN RAY SOCIETY

The Middle Section of the AMERICAN ROENTGEN RAY SOCIETY met at the Hotel Congress in Chicago, February 20-21, 1920, at which time the following program was presented: The Correlation of *X*-Ray and Pathological Findings in the Diagnosis of Bone Lesions, Dr. D. B. Phemister, Chicago; Radiotherapy of Thyroid Malignancy with Report of Case, Dr. James T. Case, Battle Creek, Mich.; A Method for Making "Instantaneous" Roentgenographs of the Heart at Determined Points in the Cardiac Cycle, Professor J. A. E. Eyster, Madison, Wis.; A Preliminary Report on Some Roentgenological Studies of the Feeble-minded, Dr. M. William Clift, Flint., Mich.; Further Roentgen Experience with Oxygen Inflation of the Peritoneal Cavity, Dr. William H. Stewart, New York City; The Treatment of Uterine Fibroids, Dr. Thomas A. Burcham, Des Moines, Iowa; Abdominal Angina, Dr. A. W. Crane, Kalamazoo, Mich.; Cancer Ameliorations and Cancer Immunity, Dr. A. F. Holding, Madison, Wis.; Report of Four Unusual Cases of Malignancy Successfully Treated by Roentgen Therapy, Dr. A. F. Tyler, Omaha, Neb.; A Portable Localizing Fluoroscope, Dr. Edwin C. Ernst, St. Louis, Mo.; Reduction of Fractures under Fluoroscopic Control with Description of a New Unit and Fluoroscopic Table, Dr. Preston M. Hickey, Detroit, Mich.; The Diagnosis of the Pathological Gall-bladder, Dr. A. W. George, Boston, Mass.; Fractures of the Bones of the Face, Dr. Charles F. Bowen, Columbus, Ohio.

The papers were of unusual interest, the attendance was extremely gratifying and every one there felt well repaid for making the trip to the meeting.

The Constitution and by-laws which were adopted by the Eastern Section at Atlantic City were adopted with necessary changes by the Middle Section.

The following officers were elected for the Middle Section:

President
James G. Van Zwaluwenburg, Ann Arbor, Mich.
First Vice-President
Wm. M. Doughty, Cincinnati, Ohio
Second Vice-President
Edwin C. Ernst, St. Louis, Mo.
Secretary-Treasurer
A. F. Tyler, Omaha, Neb.

At the banquet in the evening, sixty-three guests were present. Dr. E. H. Skinner, of Kansas City, presided as toastmaster. Drs. James T. Case, A. F. Tyler and Alexander B. Moore responded to toasts. The banquet was followed by a lantern slide demonstration.

CO_2 INSTEAD OF O_2 FOR INJECTING THE PERITONEAL CAVITY

The February, 1920, number of the *California State Journal of Medicine* contains an article by Walter C. Alvarez of San Francisco, describing his experiences with the injection of the peritoneal cavity by O_2 and other gases, as follows:

After working with the technic of O_2 injections for a few days, it seemed to Dr. Alvarez that its usefulness would have to remain limited largely to hospital patients, unless some means could be found of getting rid of the gas more promptly. Although in most cases the oxygen was sufficiently absorbed in two or three hours, so that the patient could leave the office, few cared to work next day; and one man still had a large amount of gas in his abdomen after five days. Hence Dr. F. B. Taylor and Dr. Alvarez began injecting rabbits at the Hooper Foundation with various gases, and soon found, as was expected, "that CO_2 would be absorbed many times faster than O_2. After satisfying ourselves that the procedure was harmless, we began using CO_2 at the office and have since made it almost a routine. The great advantage of this method is that we can assure the patient that in twenty-five minutes his gas will be out, his distress will be over, and he can go back to his work as if nothing had happened." The disadvantage is the difficulty in getting all the plates wanted. Moreover, if a plate should be unsatisfactory for any reason, or if on development something should be found which required further study, it might be too late. "We overcome this difficulty somewhat by having three people working rapidly; one developing as fast as the plates are taken. It may be, now, that by adding a little O_2 we can slow the emptying a little and yet retain the great advantages which have been gained with the new technic."

SUMMARY.—A technic is described which the writer believes marks the biggest step in advance as regards intra-abdominal diagnosis since the bismuth meal was introduced. After injecting gases into the peritoneal cavity the intestines will float out of the way, and the various organs will move around so that beautiful *x*-ray plates can be secured of the diaphragm, liver, spleen, gall-bladder, kidneys, gastrointestinal tract, spine, uterus and ovaries. This technic has proven particularly helpful in the diagnosis of gall-bladder disease. By using CO_2 instead of O_2 the writer has modified the original procedure so that it may now be used in the office as well as in the hospital. Whereas the O_2 leaves the abdomen in from 24 to 100 hours, the CO_2 leaves in half an hour. This seems to be a distinct advance and certainly merits the consideration of all those who are interested in this type of work.

TRANSLATIONS & ABSTRACTS

MEDICAL SCIENCE: Abstracts and Reviews. (Vol. I, No. 2, Nov. 1919.)

Joltrain and Baufle draw attention to the occurrence of localized latent peritoneal tuberculosis in patients with vague abdominal symptoms. *X*-ray examination, which is essential for the diagnosis, shows a dilatation of the lower end of the ileum, in which there is an obstruction to the passage of the bismuth meal. As a rule this dilatation is associated with immobility of the colon, due to the existence of adhesions, which are found not only in the region of the ileum but also throughout the large intestine, especially at the flexures and in the sigmoid.

SURGERY OF THE THYROID AND THYMUS GLANDS

Examination by *x*-ray is of importance as showing the effect of pressure upon the trachea, also as disclosing an enlarged thymus or retrosternal goitre. Deuk and Hofer say that among 1,967 cases operated upon in Vienna for non-malignant goitre, in 11 cases there was softening and collapse of the trachea, necessitating tracheotomy. An *x*-ray plate made anteroposteriorly will show the commoner lateral compression of the trachea, but a lateral plate is necessary in order to demonstrate the rarer anteroposterior compression.

Sgalitzer described his method, by which lateral and anteroposterior plates were made so as to show lengthening and bending of the trachea by the goitre, as well as the level and extent of the compression.

Mayer found that *x*-ray negatives also enabled a diagnosis to be made of interthoracic goitre and enlarged thymus, although a dermoid cyst cannot be distinguished from the above. The retro-sternal goitre may be a continuation of the goitre in the neck, but an intrathoracic goitre may exist without any enlargement of the neck gland. Moreover, accessory thymoids may be met with at any point in the line, from the base of the tongue as far down as the front of the arch of the aorta and pericardium, or even in the posterior mediastinum.

Oehler noted that when the growth in the thyroid was malignant, the outline of the trachea as seen by the *x*-ray was obscured or was not visible at all. The obscuring of the trachea by cancer is probably due to dense infiltration around the trachea, and is distinct from the question whether the cancer is compressing the trachea.

GASTRIC AND DUODENAL ULCERATION

The differentiation of duodenal ulceration was first made by Moynihan in 1901. The following were the chief points in his description: That duodenal ulceration was of more frequent occurrence than gastrict ulceration; that it chiefly occurred on the anterior wall of the duodenum just beyond the pylorus; that men are more frequently affected than women; the occurrence of the so called hunger pains one and a half hours after meals; the pain referred to the right of the midline of the epigastrium and the back of the chest of the same side; the relief of the pain by taking food or an alkali. The periodicity of the attacks corresponding presumably to the healing and recurrence of the ulceration; hyperchloridia as a particular indication of duodenal ulceration; the occurrence of melena including "occult" blood.

GASTRIC SPASM AND X-RAY EXAMINATIONS

Greater experience with the appearances reproduced in *x*-ray photographs and their interpretation has added to the means of making a more exact diagnosis, as well as the recognition of spasm and its causation of pain.

Müller attributed gastric pain, especially during the emptying of the stomach, to irregular spastic contraction of the pyloric third of the stomach, as shown by the *x*-rays. But also, whilst the stomach is empty, spasmodic contractions occur, which may be the cause of the so-called hunger pain. The spasmodic contraction may involve not only the muscular wall of the stomach but also the gastric arterioles. The gastric crises in tabes dorsalis may be explained as due to strong peristaltic and antiperistaltic contraction of the walls of the stomach.

Indeed, the production of pain by hyper-

acidity may be exaggerated. The normal mucous membrane in dogs is not specially irritated by hydrochloric acid, even in excess of the normal, and there are many ulcers of the stomach which do not cause pain.

Fleiner, by *x*-ray examination, explained cardiospasm as starting in the oesophagus and spreading to the cardiac portion of the stomach. No special sphincter was recognized at the cardiac orifice. By means of spasmodic contraction a tube was formed along the lesser curvature of the stomach leading towards the pylorus. The tube so formed was reminiscent of the normal condition of this part of the stomach in ruminants. A continuance of the occurrence of spasm of the lower third of the oesophagus and upper part of the stomach might lead to the formation of cancer with dilatation of the oesophagus above the region of spasm.

Schütze stated that in 60 per cent. of cases suspected of gastric ulcer the *x*-ray photographs presented indentation of the greater curvature of the stomach, which he attributed to hypertonic contraction of the gastric wall with an infolding of the mucous membrane. Whilst in the majority of cases gastric ulceration was indicated, it was also seen in connection with duodenal ulceration, and less often with cholecystitis.

Groedel, however, did not agree with Schütze; indeed he doubted whether such pictures of indentation could be taken as signs of pathological conditions at all.

THE RELATION OF GASTRIC AND DUODENAL ULCERATION TO CANCER

Two recent American communications express doubts as to the frequency with which simple ulcerations degenerate into cancer, and tend to revert to the old view that cancer generally begins as such. According to Ewing, cancer is widespread with extensive induration and uniform infiltration, an erosion with here and there excavations. Simple ulcers are circumscribed with smooth overhanging edges; there is, however, often a glandular hypertrophy with fibrosis of the submucosa which produces a resemblance to cancerous infiltration.

Willensky and Thelimer examined microscopical specimens of gastric ulceration. Thirty-nine specimens proved to be instances of simple chronic ulcer in accordance with the naked eye appearances. Seven specimens in which the appearance at the operation resembled carcinoma, proved also to be simple ulcers. One was a specimen of simple ulceration, but there was a nodule of carcinoma at one margin. In cases of carcinoma so early that the lymphatic glands are not involved, an excision carried 2 cm. beyond the ulcerated margin appeared to remove all the malignant disease.

There does not, however, appear to be any trustworthy means of distinguishing cancer when exposed at the operation, at least at a stage early enough to promise success after excision, except by the immediate examination under the microscope of a fresh section.

Troell reported on the fate of the cases diagnosed in the Stockholm Hospital as irremovable cancer of the stomach during the years 1907–14.

One hundred and thirty-seven cases were diagnosed as cases of irremovable cancer and were treated by gastroenterostomy. Of these, 70 were reported upon later; 60 died within one to thirty-five months of cancer, 9 of them surviving more than a year. The average duration was seven and a half months. Seven died of cancer at an unknown date; 3 were alive and free from cancer eight years, seven and a half years, and six years later respectively.

One hundred and thirty-four cases were diagnosed as cases of irremovable cancer of the stomach as the result of exploration, without anything further being done. Fifty-two of these were reported upon later; 49 died within one to thirty-five months, 3 living longer than a year; 1 died of cancer at an unknown date; 2 were alive six and three quarters years after without a sign of cancer.

Thirty cases were diagnosed as inoperable cancer of the stomach without any exploration: 26 died within one to twenty-six months; 1 died seventeen months later of tuberculosis; 3 were alive without any sign of cancer eight and a half, eight and a quarter, and four and a half years later respectively.

Statistics from the same hospital of 90 cases of cancer of the stomach treated by excision concluded that the average duration of life after the excision was from fifteen to twenty months, as compared with seven and a half months after gastroenterostomy.

The primary mortality among the cases of cancer was:

In the 25 per cent. submitted to excision, 19 per cent.

In the 38 per cent. submitted to gastrojejunostomy, 17 per cent.

In the 37 per cent. submitted to exploration, 16 per cent.

i.e. an average primary mortality of about 18 per cent.

Thus in selected cases the mortality following the excision of the cancer did not greatly exceed those following the gastrojejunostomy.

Gastrojejunostomy when malignant disease is present is attended by more than double the mortality which follows the operation in cases of simple ulceration.

RANSOHOFF, J. LOUIS. Late Results in the Radium Treatment of Cancer of the Uterus. (*J. Am. M. Assn.*, Vol. 74, No. 3, p. 163, Jan. 17, 1920.)

What place shall radium have in the treatment of carcinoma of the cervix? This is a question of vital importance, as it concerns the treatment of a disease of universal distribution, a disease which in spite of the efforts of the world's greatest surgeons continues to take its large annual toll of suffering and death.

Carcinoma of the cervix has long been one of the most fruitful fields for radium treatment. Thousands of cases are annually declared inoperable and must needs be aided by some other means than surgery. Because of its unusual accessibility, radium can be brought into close contact with the neoplastic cervix where it can exert its direct influence.

Radium has long been granted its position as the agent of choice in the treatment of inoperable cervical carcinomas. The question which now concerns us is whether it shall supplant the radical operation in the treatment of so-called operable cancers of the cervix. I say "so-called" advisedly, as the question of operability depends entirely on the judgment of the individual operator, and in numerous instances cannot be definitely decided until after the abdomen has been opened.

With the publication of an account of the Wertheim operation in 1898, and its adoption by the leading gynecologic clinics of the world, it was thought that a step forward had been taken in the war against uterine cancer; but now, after two decades, the Wertheim operation is still on trial. One of the most distressing phases of carcinoma of the uterus is the low percentage of operability among those patients applying for relief. In a decade, Clark[1] operated on sixty patients and estimated that during the same period more than 300 were refused operation, an operability of only 15 per cent.

In Jacobson's[2] collection of 5,027 cases, only 1,720, or a little over 31 per cent, were considered operable. In reviewing the statistics of the Wertheim operation it would seem that the higher the percentage of operability in a given series of cases, the higher the percentage of operative deaths. Probably more discouraging than the small percentage of operability is the high immediate mortality. The operative mortality of Jacobson's collected cases was 18.25 per cent. These figures, bad as they are, nevertheless leave too optimistic an impression, as they represent the work of the most skilled gynecologists of the world. In the hands of the great body of operating surgeons, the mortality is undoubtedly far larger.

Peterson,[3] in his own cases, had a total primary mortality of 25.4 per cent. In speaking of the operation he says:

"Unquestionably added experience has strengthened my belief that the extended operation for cancer of the cervix is an exceedingly dangerous one, always attended by high primary mortality. No one will be more glad to discard the radical abdominal method than will I, if I can be shown that more patients can be ultimately cured by less dangerous methods."

Turning again to Jacobson's statistics, of 1,090 patients operated on that were followed, there were 386 cures, or 35.41 per cent of the patients that were traced, or only 19.32 per cent of the entire number of patients operated on; but what is most striking is that only 11.72 per cent of all those patients applying for treatment were cured.

Clark has struck the keynote of modern opinion of the Wertheim operation. He says:

"If an operation or other therapeutic process is to have a permanent place in our armamentarium it must be sufficiently easy to make it available not for a few skilled specialists, but for the great body of surgeons working in every quarter of this and other countries."

In these days of low mortality percentages attending nearly all major operations, no operation can possibly gain headway which com-

bines with it a shockingly high mortality and a large majority of distressing and desperate sequelae. The effect on the lay mind must be taken into consideration, for while one may have over 50 per cent of ultimate cures among those patients that survive the operation, the effect on the average intelligent citizen is abhorrent, if for this number of survivors there have been twenty-five deaths, and for the other twenty-five a wretched existence attended by repulsive postoperative sequelae, followed by a painful and lingering death. It is possible that when we make a final summary of our combined experiences we may have to accept the conclusion that a less radical operation, even though it saves fewer patients, may be preferable when attended by a low surgical mortality and few or no operative sequelae.

A CONTRAST OF METHODS

Disregarding for a time the end-results of radium treatment of cancer, it is interesting to compare the two methods of treatment from other standpoints. Contrasted with the high mortality of the extensive operation for uterine cancers, there is practically no mortality from the radium treatment. In place of a dangerous operation with its attendant suffering, long stay in the hospital, and distressing postoperative sequelae, there is the simple radium treatment with a few days' stay in the hospital, no danger and little pain.

Again, while less than one third of those patients who present themselves for treatment are fit subjects for the radical operation, radium treatment is available for all classes of cases, no matter how far advanced. The immediate result of treatment, and the palliation of symptoms, the relief from hemorrhage, pain and foul discharge have been too frequently described to warrant further comment.

The conclusions published by Dr. J. Louis Ransohoff [4] in 1916 remain unchanged. That is, in all cases the immediate results have been without exception good. The concern now is, Can radium permanently cure cancer of the cervix? If so, does the percentage of cure equal that of operation? If that is true, the conclusion is obvious.

The pendulum is swinging toward radium as the method of choice in the treatment of operable cervical carcinomas. With the report of later results, its position is becoming more definitely established. As early as 1914, there were some operators convinced that radium should entirely supplant operation. Dobbert [5] in that year, from an observation of twenty-four cases, eighteen inoperable and six operable, concluded that it was justifiable to use radium alone in the treatment of operable cases. Cheron [6] reported an inoperable case in which radium was used. Two and one-half years after treatment, death occurred from intercurrent disease. Necropsy revealed no trace of cancer.

In 1915, Döderlein [7] definitely advocated the use of radium in operable cases. Pozzi,[8] in 1915, had given up the Wertheim operation in borderline cases and treated them with radium alone. In cases which are decidedly in their inception, a simple vaginal hysterectomy is done, followed by prophylactic radium treatment. Flautau,[9] in 1915, definitely relinquished operation in favor of radium. The title of his article was, "May We Trust Radium Alone in the Treatment of Uterine Cancers?" In the same year, DeGrais [10] reported both operable and inoperable cases free from recurrence four years after treatment.

A very important contribution is one of Recasens, a Spanish surgeon. In the beginning he used radium only in those cases too far advanced for operation; but later he used radium to the exclusion of operation. He believes that in very early cases, a cure by radium is almost certain.

RESULTS IN THE AUTHOR'S SERIES OF CASES

As Dr. Joseph Ransohoff and Dr. J. Louis Ransohoff began the use of radium in the treatment of malignant disease in February, 1914, this report represents the results of nearly six years' experience.

On Dr. J. Louis Ransohoff's return after two years in the army, he was interested in the fate of those patients whom he had seen in the three years prior to his entrance into the service. With the exception of the last case, which was two months later, this series includes those cases observed between February, 1914, and April, 1917, a period varying from two and one-half to nearly six years. As far as possible, all patients were traced; those that could not be located were regarded as having succumbed to the disease.

There are in all thirty-two cases. This includes all patients observed, varying from those whose cases were operable to those in a

terminal stage of sepsis. There are also included cases in which for one reason or another the treatment was not complete. It is interesting to note that eight of these patients had what was considered an incomplete course of treatment, that is, three or less radium applications. The average number of applications for all cases, healed and fatal alike, was six. There were six recurrent and twenty-six primary cases treated. There were two cases of cancer of the fundus, and thirty of cancer of the cervix, so that this report deals principally with cervical carcinoma.

Of this entire series there were six patients, or 19 per cent, well and free from all evidence of diseases at intervals varying from nearly three to five and one-half years after treatment. In the two cases of carcinoma of the body of the uterus, the results have been disappointing. Neither of these cases, however, was operable. Nevertheless, he is of the opinion that these patients when possible should be operated on rather than treated with radium, as the operative mortality is low and the end-results good. One of these cases is worth reciting in detail:

Miss C. M., aged thirty-four referred by Dr. Palmer, had been having uterine hemorrhages for eight months. Three weeks before my examination, a curettage revealed an adenocarcinoma of the body of the uterus, which was confirmed by microscopic examination. The first radium treatment was given July 3, 1914. In July, 1917, the patient was well. During the fall of 1918, she developed a pernicious vaginal hemorrhage, which was controlled by roentgen-ray treatments. Examination revealed what was thought at that time to be a large fibroid. A month before, these hemorrhages had again recurred. A piece was removed for section and proved to be an adenocarcinoma. One reason for the persistence of this tumor was probably the age of the patient, as it is well known that carcinoma is far more malignant in young persons than in those who are older.

Deducting the eight cases in which an incomplete series of treatments were given, we have 25 per cent relief from symptoms during this period. There has been no definite operable case in which the treatment has not been successful.

Case 1. Mrs. I. F., aged fifty-three, six months before had noticed sudden pains in the lower abdomen and for four months had suffered from bleeding from the uterus. The family history was negative. Examination, April 28, 1914, revealed an ulcerating epithelioma involving the entire anterior lip of the cervix. The uterus, however, was freely movable. A small piece removed for examination revealed epithelioma. The first radium treatment, September 11, 1914. Hemorrhage ceased after the first three treatments, and there had been no evidence of recurrence. The patient was in perfect health. In July, 1919, examination revealed a normal movable uterus, with no evidence of any ulceration, a freedom from recurrence after five and a half years.

Case 2. Mrs. K. H., aged seventy-one, for seven months had had severe vaginal hemorrhages. Examination disclosed carcinomatous degeneration of the entire cervix. There was a microscopic diagnosis of carcinoma. The uterus, however, was movable. The first radium treatment was given May 1, 1915, and the last treatment, May 29, 1915. There were in all four treatments. The patient was reported well, April, 1919, a freedom of recurrence after four and one-half years.[11]

Case 3. Mrs. S., aged forty-five, had been bleeding off and on for eight months. She was very much exsanguinated and was severely emaciated. Examination revealed a cancerous mass filling the vagina. A microscopic diagnosis of carcinoma was made. Under an anesthetic the mass was curetted away, the vagina was cauterized, and 100 mg. of radium were inserted for twenty-four hours. March 20, 1915, the first treatment was given, and the last treatment was given, May 7, 1915. April 25, 1919, examination revealed the patient perfectly well and able to do her work Her weight was 124½ pounds. September 10, 1919, a recto-vaginal fistula developed. Examination under anesthesia disclosed a very small fistula in the posterior vaginal wall, communicating with the rectum. This fistula was situated just above a very dense fibrous stricture. Under an anesthetic, the stricture was stretched and a very careful examination revealed no evidence of cancer. Here the stricture was probably due to the concentration of a large number of treatments in a short time, necessitated by the desperate nature of the case. An examination made a week ago demonstrated the fistula nearly healed and absolutely no evidence of

any tissue remotely resembling carcinoma, a freedom from recurrence for four and a half years.

CASE 4. Mrs. S. S., aged sixty-five, had been bleeding for eight months. Examination disclosed the cervix entirely replaced by the neoplastic tissue. There was a foul discharge and hemorrhage. A microscopic diagnosis of carcinoma was made. The first treatment was given in February, 1916, and the last treatment in April, 1916. Examination, November, 1919, revealed the patient in excellent health. The vaginal vault and the remains of the cervix were covered by smooth, pliable mucosa; there was no evidence of a recurrence, a freedom from recurrence of nearly four years.

CASE 5. Mrs. J. W., aged fifty, with symptoms present for eight months, had had severe hemorrhage. The site of the cervix was occupied by a crater and cancerous vegetation. It was probably a borderline case. Under gas oxygen anesthesia, a curettage was performed. A microscopic diagnosis of carcinoma was made. The first treatment was given, December, 1916, and the last treatment, July, 1917. Examination, December, 1919, revealed a woman in excellent health, with no evidence of recurrence. There was a small scar in the vault of the vagina covered with normal mucosa, a freedom from recurrence for three years.

CASE 6. Mrs. B., aged fifty-four, was operated on for cancer of the uterus two years before. She had had hemorrhage for the past two months. The vagina was narrow, and there was a recurrence in the vault. The first treatment was given in June, 1917, and the last treatment in December, 1917. The patient reported by letter, November, 1919, that she was well, a freedom from recurrence of two and a half years.

COMMENT

We have here 19 per cent of those patients treated free from recurrence for from two and one-half to five and one-half years; one patient for five and one-half years; two patients for over four years; one patient for three years, and one for two and one-half years. The latter case may perhaps be a little too recent to be definitely called cured. This percentage of cure may seem small, but it compares favorably with that following operation. Deducting the eight cases in which the treatment was incomplete raises the percentage to 25.

The remaining twenty-six patients are either known to have died of the disease, or have at present a recurrence, or could not be traced.

Just a word here as to technic, that is, the question as to whether the radium treatment should be preceded by a curettage or the cautery. From their observation it would seem that the results were the same one way or the other; therefore they have definitely given up both curettage and cauterization as preliminary to radium treatment, and now depend entirely on the radium.

If the cases were chosen for radium treatment with the same degree of care that they are chosen for operation, he feels confident that the percentage of cures would be very large. This is not, however, the function of the radium workers, who should give an opportunity for relief to every person who seeks treatment.

There is scarcely any case so far advanced that some improvement may not be obtained from radium treatment. In this work it should be the province of all observers not to work for statistics, but to give every patient a chance, if not for a cure, at least for an amelioration of symptoms.

Contrast the results of these thirty-two cases in which there was a 19 per cent cure, with the Jacobson statistics, in which there was only an 11 per cent cure. Also remember that there was no fatality from this entire series of treatment. Contrast this with the 18.25 per cent mortality from the radical operation. Contrast again the economic saving of weeks in the hospital, the postoperative suffering, and the unbearable sequelae. He does not hesitate to state that in his opinion radium treatment should entirely supplant operation, not only in the treatment of inoperable cases, but also in the treatment of operable cases of cancer of the cervix.

W. W. BELDEN.

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9. Flautau: *Zentralb. f. Gynak.*, 39:611, 1915. 264, 1914-1915.
10. DeGrais, P.: *Ann. de gynec. et d'obst.* 11, 1919; *Surg., Gynec. & Obst.* 22: 298 (March) 1916.
11. Since this article was written, this patient has died of some inter-current disease, at the age of 76.

Dr. Petit de la Villeon. The Extraction of Intrathoracic Projectiles. (*Am. J. Surg.*, Vol. XXXIII, No. 12, December, 1919.)

THE SURGICAL PRINCIPLE

A blunt instrument, introduced slowly into the lung parenchyma, living and healthy, causes no damage, provided that it follows a single tract, and does not penetrate the region of the hilus. This is the fundamental law on which the method is based, a physiological law never before formulated, and possibly disputed, but which I believe, may be accepted as true. On account of the elastic and resilient consistency of the living and healthy pulmonary parenchyma, the blood vessels and bronchial structures, which are not attached to anything, nor obstructed by anything are turned aside by the blunt end of the instrument, and the forceps passes by them.

THE REGION OF THE HILUS

"A scapulo-vertebra trapezium limited internally by the spine, externally by the vertebra border of the scapula in its lower half, above by the fifth rib, below by the eighth rib." Projectiles that throw their shadow in this trapezium, and situated at a depth of from 6 to 14 centimeters beneath the posterior projection of the shadow, occupy the hilus region forbidden to the forceps. Up to the present time surgeons have not dared to attack these projectiles in the hilus, but impelled by the dangers of foreign bodies in this location and the possibility of formidable hemorrhage which might result from them, operators have begun to take courage. Le Fort and Pierre Duval have had had good results with brilliant methods, and for projectiles in this region the author advises "Posterior radio-operative thoracopneumotomy." The operation may be performed under strong red-orange light, under *x*-ray with the fluoroscopic screen, or by white daylight. Aided by resection of the posterior ribs, and by a total pneumothorax, he enters the hilus from behind forwards, completes the extraction, and packs with a deep tampon. The tampon is removed after two or three days according to the case, always with extreme gentleness. He thus operated upon 17 cases, with 17 cures, two of the cases developing empyema. In pleural and diaphragmatic situation of projectiles surgery can accomplish the removal, without danger, if the surgeou is eclectic and varies his methods. Extraction with forceps under the fluoroscope through the buttonhole incision is admirably adapted to all projectiles in the pleura, excepting only in the mediastinal pleura. Here, if the surgeon decides to intervene, he should do so only with all resources available for major thoracotomy, according to the method of Delarine, Fonta, Pierre Duval, or Le Fort. At the level of the diaphragm, he suggests that projectiles be divided into three groups, according to the region which they occupy. First group; projectiles in the right diaphragm. Second group; projectiles in the left diaphragm. Third group; projectiles in the medium or mediastinal diaphragm. In conclusion, extraction of intrathoracic foreign bodies has been improved considerably by perfection and simplification of the technique, particularly by the association of the *x*-ray in radio-operative methods.

Vaccarezza, Dr. Raul F. Las Intoxicaciones Por El Subnitrato de Bismuto.

This article fails to produce any new facts in regard to poisoning with subnitrate of bismuth. After relating a case of fatal poisoning with bismuth subnitrate at the Instituto Modelo De Clinica Medica, and mentioning several others happening in the same place, and also referring to similar cases in literature, the author describes very extensively the intoxication of external as well as of internal origin; Beck's paste has caused a large number of poison cases and several fatal ones.

Poisoning sometimes follows the administra-

tion of large doses as administered in radiographic examinations. There also are reported quite a number of cases where large doses of bismuth subnitrate were given for a long time in the treatment of gastric ulcers. The most important symptom is a generalized cyanosis, and almost all these cases proved to be due to obstruction at the pylorus or in the intestines, thus allowing the bismuth subnitrate to accumulate and to be absorbed in the gastrointestinal tract.

The acute poisoning is due to the absorption of nitrates formed in the intestinal tract from the subnitrate under the influence of certain intestinal bacteria. They are very rapidly absorbed in the blood where the hemoglobin is changed into methoglobin. Another reason is that if the salt is administered in an alkaline medium it very quickly chances into a soluble albumen which is quickly absorbed through the mucosa of the mouth and lips.

On account of this poisoning action it is out of the question to employ the subnitrate of bismuth in radiographic examinations of the gastrointestinal tract, as very large doses have to be given. In administering the subnitrate of bismuth as a therapeutic measure in gastrointestinal diseases this danger prevents its continued use, and if used it must be employed only in very small doses. In external use also it must be employed with much care, never exceeding the dose of 30 cubic cm. of Beck's paste of 10 per cent.

PEER M. LUND.